Hiroaki INOUE et al.
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Filed March 24, 2004

FIG. 1

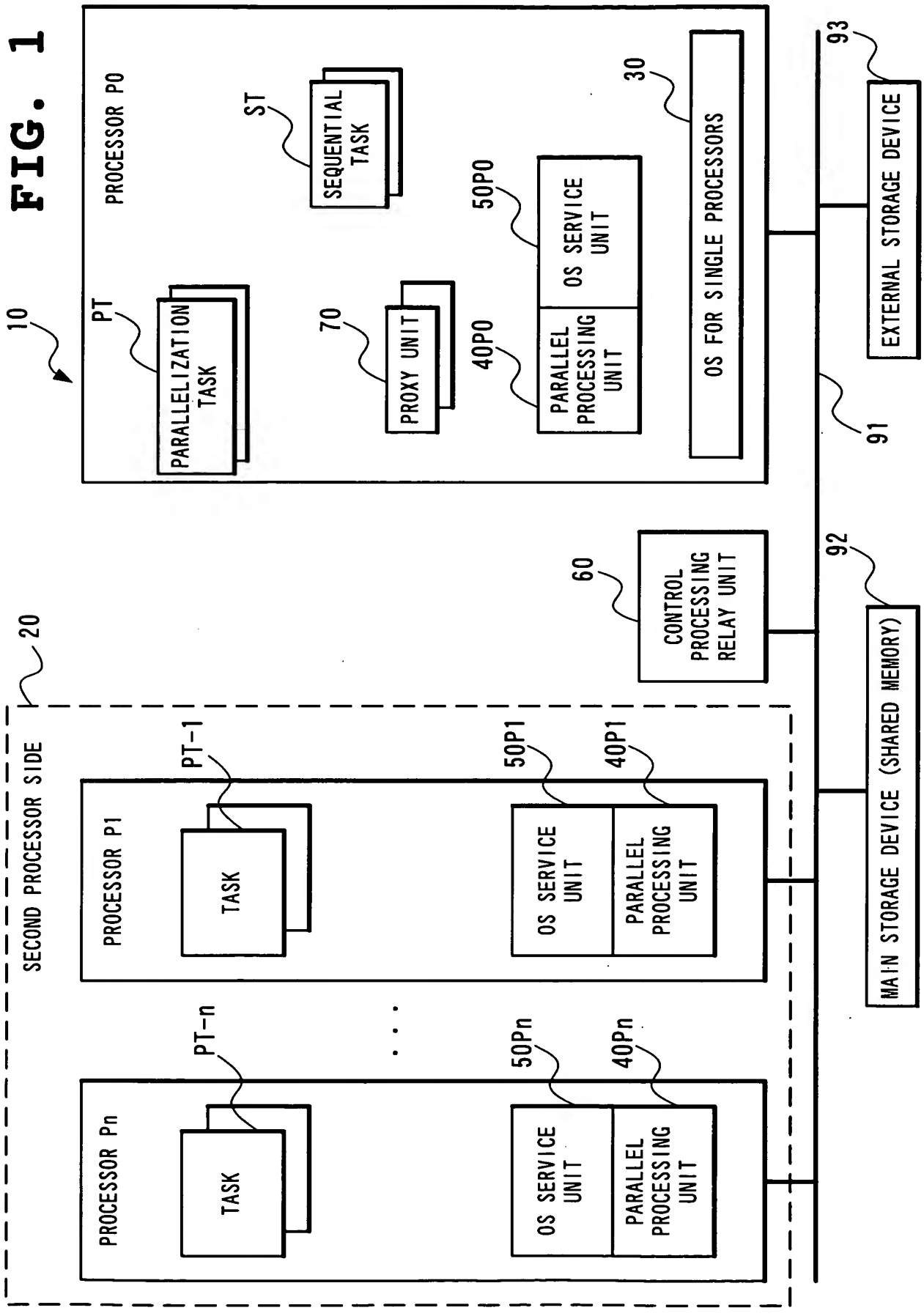

FIG. 2

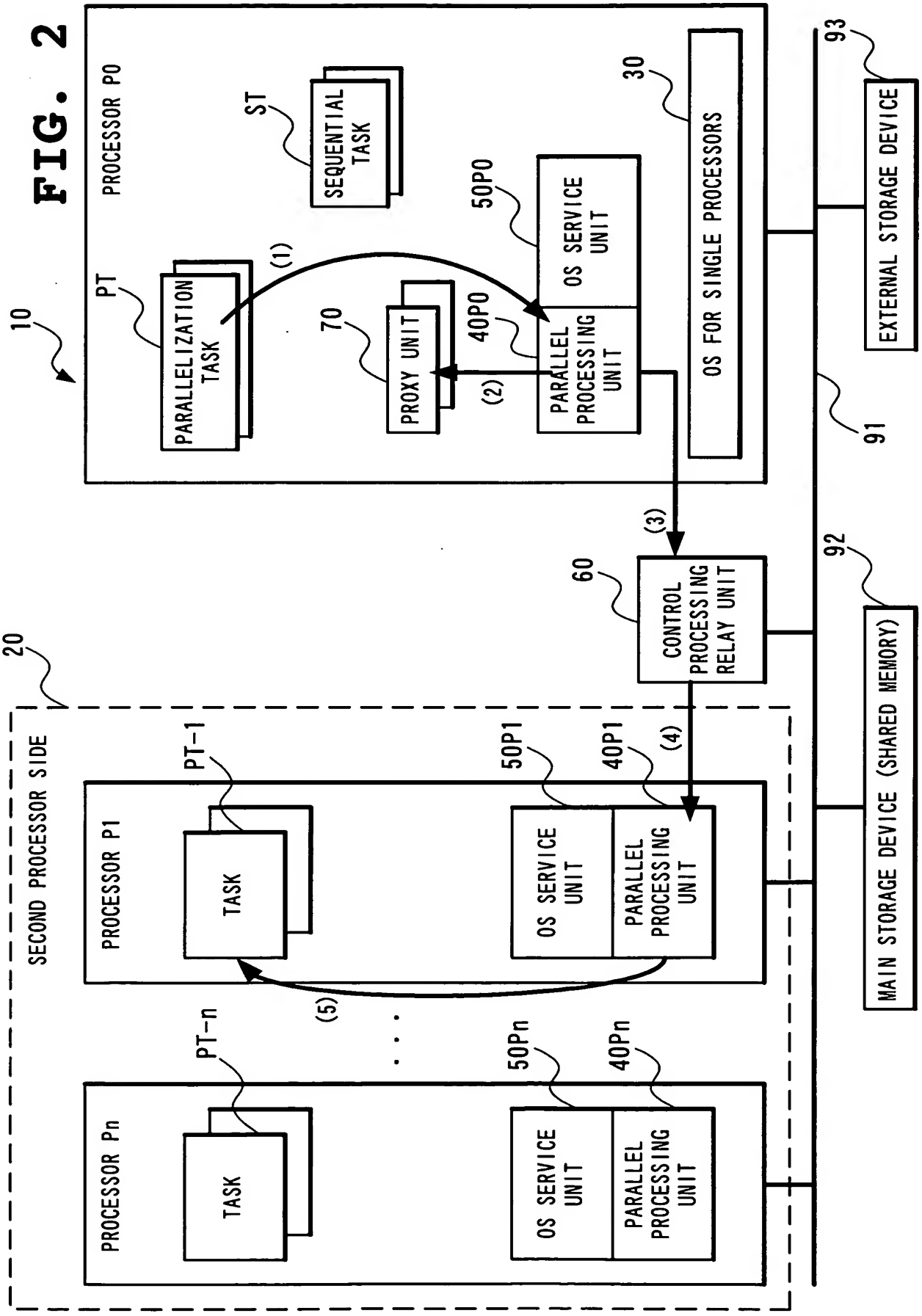
10
PROCESSOR P0
PT
PARALLELIZATION TASK
ST
SEQUENTIAL TASK
70
PROXY UNIT
50P0
OS SERVICE UNIT
40P0
PARALLEL PROCESSING UNIT
30
OS FOR SINGLE PROCESSORS
(1)
(2)
(3)
(4)
(5)
93
EXTERNAL STORAGE DEVICE
91
92
MAIN STORAGE DEVICE (SHARED MEMORY)
60
CONTROL PROCESSING RELAY UNIT
20
SECOND PROCESSOR SIDE
PROCESSOR P1
PT-1
TASK
50P1
OS SERVICE UNIT
40P1
PARALLEL PROCESSING UNIT
PROCESSOR Pn
PT-n
TASK
50Pn
OS SERVICE UNIT
40Pn
PARALLEL PROCESSING UNIT

FIG. 3

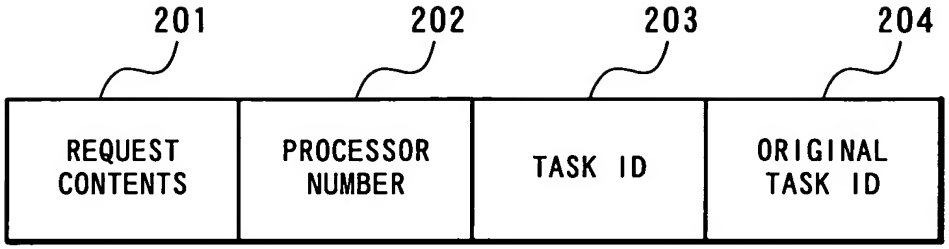
201
202
203
204
REQUEST CONTENTS
PROCESSOR NUMBER
TASK ID
ORIGINAL TASK ID

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FIG. 4

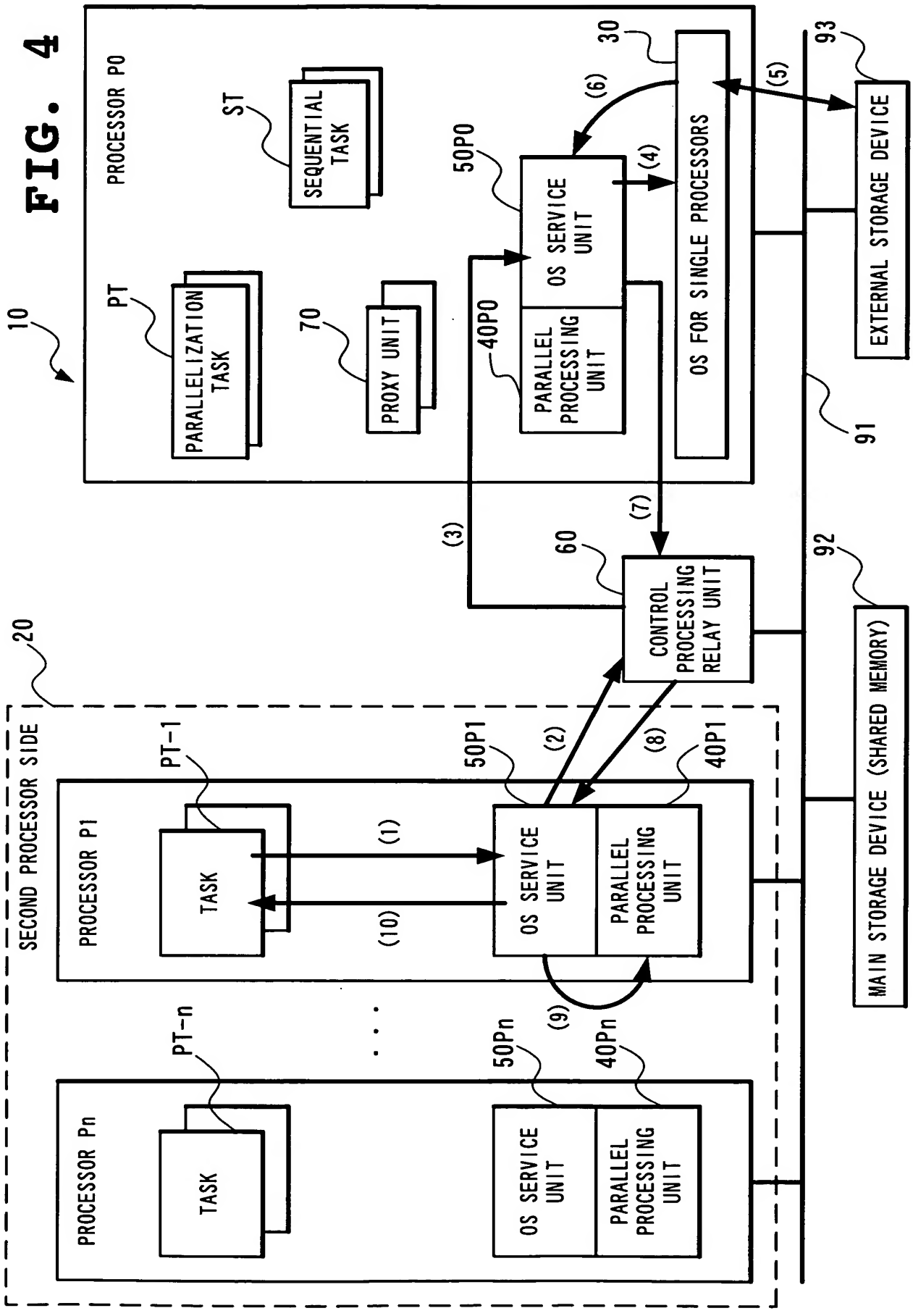


FIG. 5

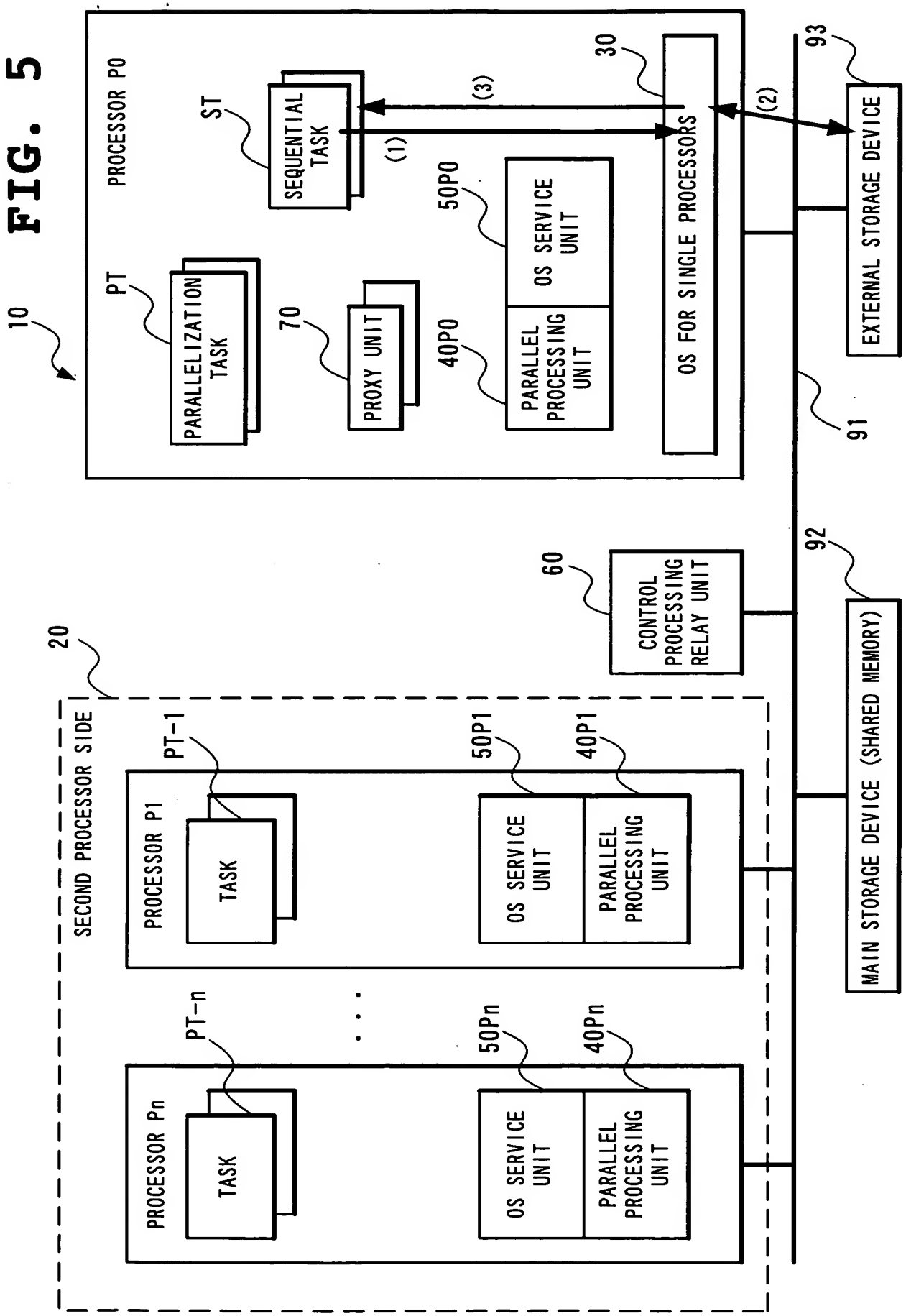

10
PROCESSOR P0
ST
SEQUENTIAL TASK
(1)
(3)
30
OS FOR SINGLE PROCESSORS
(2)
93
EXTERNAL STORAGE DEVICE
PT
PARALLELIZATION TASK
70
PROXY UNIT
50P0
OS SERVICE UNIT
40P0
PARALLEL PROCESSING UNIT
91
60
CONTROL PROCESSING RELAY UNIT
92
MAIN STORAGE DEVICE (SHARED MEMORY)
20
SECOND PROCESSOR SIDE
PROCESSOR P1
PT-1
TASK
50P1
OS SERVICE UNIT
40P1
PARALLEL PROCESSING UNIT
PROCESSOR Pn
PT-n
TASK
50Pn
OS SERVICE UNIT
40Pn
PARALLEL PROCESSING UNIT

FIG. 6

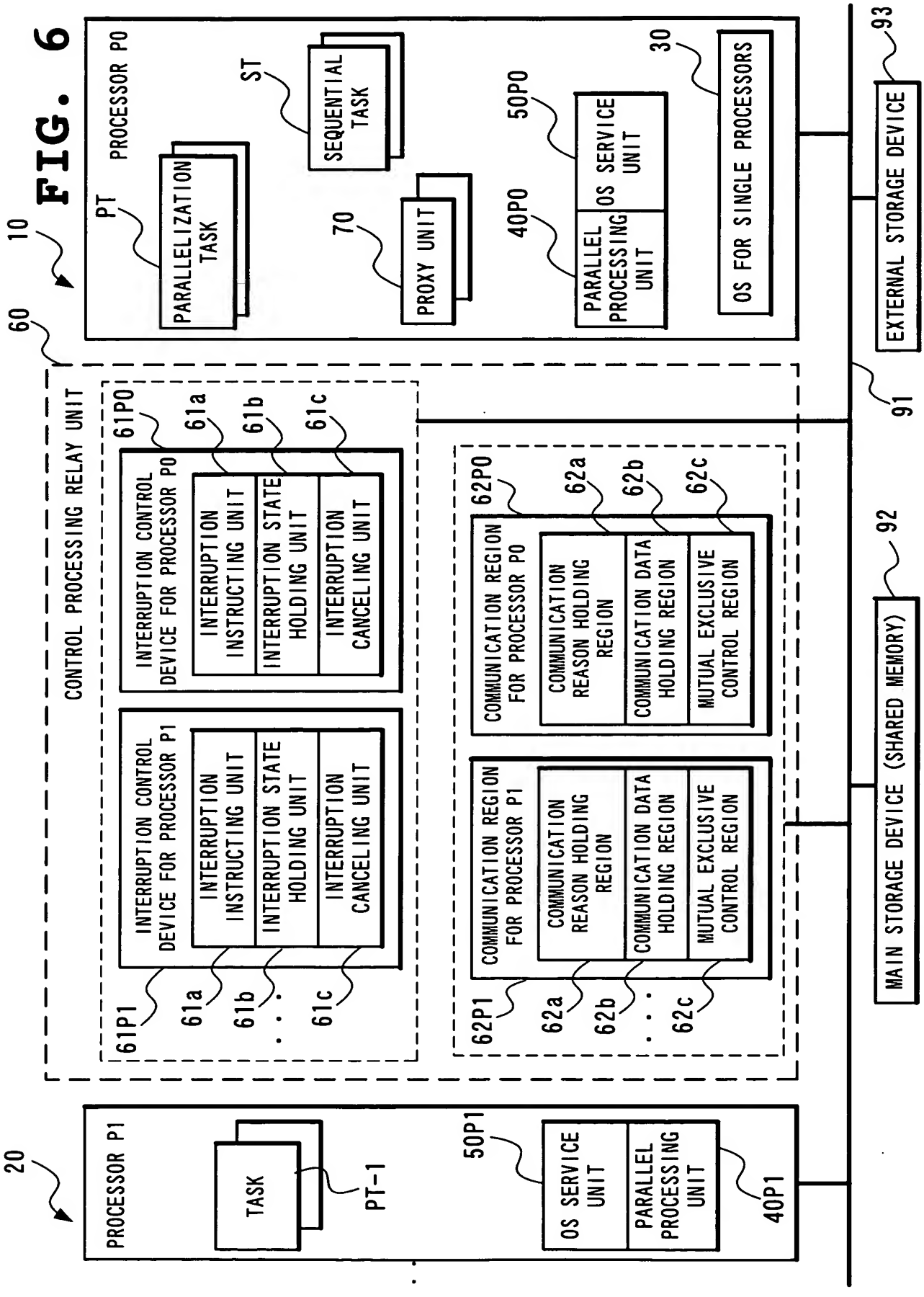

10
PROCESSOR P0
PT
PARALLELIZATION TASK
ST
SEQUENTIAL TASK
70
PROXY UNIT
40P0
PARALLEL PROCESSING UNIT
50P0
OS SERVICE UNIT
30
OS FOR SINGLE PROCESSORS
60
CONTROL PROCESSING RELAY UNIT
61P0
INTERRUPTION CONTROL DEVICE FOR PROCESSOR P0
61a
61b
61c
INTERRUPTION INSTRUCTING UNIT
INTERRUPTION STATE HOLDING UNIT
INTERRUPTION CANCELING UNIT
61P1
INTERRUPTION CONTROL DEVICE FOR PROCESSOR P1
62P0
COMMUNICATION REGION FOR PROCESSOR P0
62a
62b
62c
COMMUNICATION REASON HOLDING REGION
COMMUNICATION DATA HOLDING REGION
MUTUAL EXCLUSIVE CONTROL REGION
62P1
COMMUNICATION REGION FOR PROCESSOR P1
91
EXTERNAL STORAGE DEVICE
93
MAIN STORAGE DEVICE (SHARED MEMORY)
92
20
PROCESSOR P1
TASK
PT-1
50P1
OS SERVICE UNIT
PARALLEL PROCESSING UNIT
40P1

FIG. 7

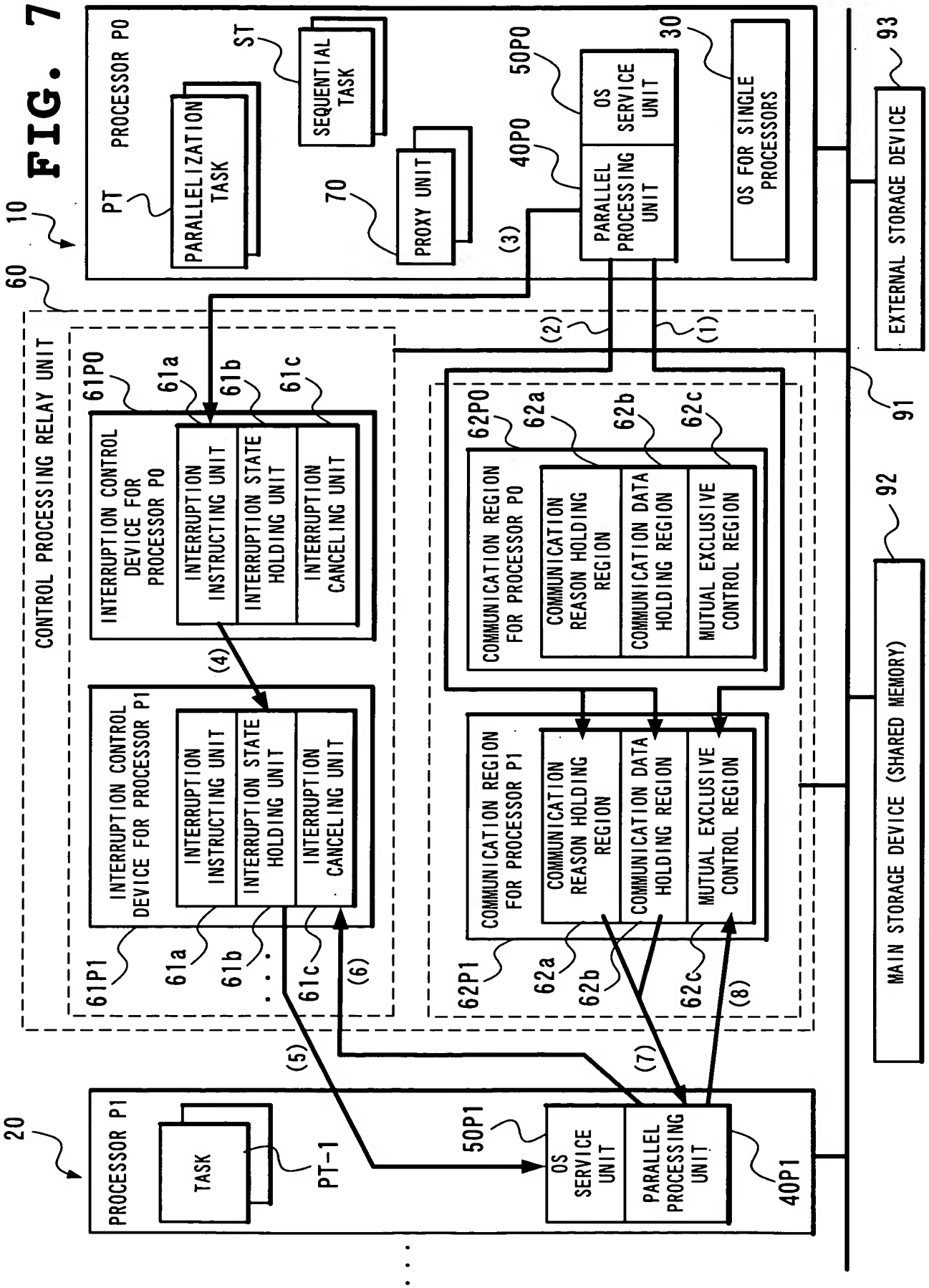

10
PROCESSOR P0
PT
PARALLELIZATION TASK
ST
SEQUENTIAL TASK
70
PROXY UNIT
40P0
PARALLEL PROCESSING UNIT
50P0
OS SERVICE UNIT
30
OS FOR SINGLE PROCESSORS
93
EXTERNAL STORAGE DEVICE
60
CONTROL PROCESSING RELAY UNIT
61P0
INTERRUPTION CONTROL DEVICE FOR PROCESSOR P0
61a
INTERRUPTION INSTRUCTING UNIT
61b
INTERRUPTION STATE HOLDING UNIT
61c
INTERRUPTION CANCELING UNIT
61P1
INTERRUPTION CONTROL DEVICE FOR PROCESSOR P1
62P0
COMMUNICATION REGION FOR PROCESSOR P0
62a
COMMUNICATION REASON HOLDING REGION
62b
COMMUNICATION DATA HOLDING REGION
62c
MUTUAL EXCLUSIVE CONTROL REGION
62P1
COMMUNICATION REGION FOR PROCESSOR P1
91
92
MAIN STORAGE DEVICE (SHARED MEMORY)
20
PROCESSOR P1
TASK
PT-1
50P1
OS SERVICE UNIT
40P1
PARALLEL PROCESSING UNIT
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)

FIG. 8

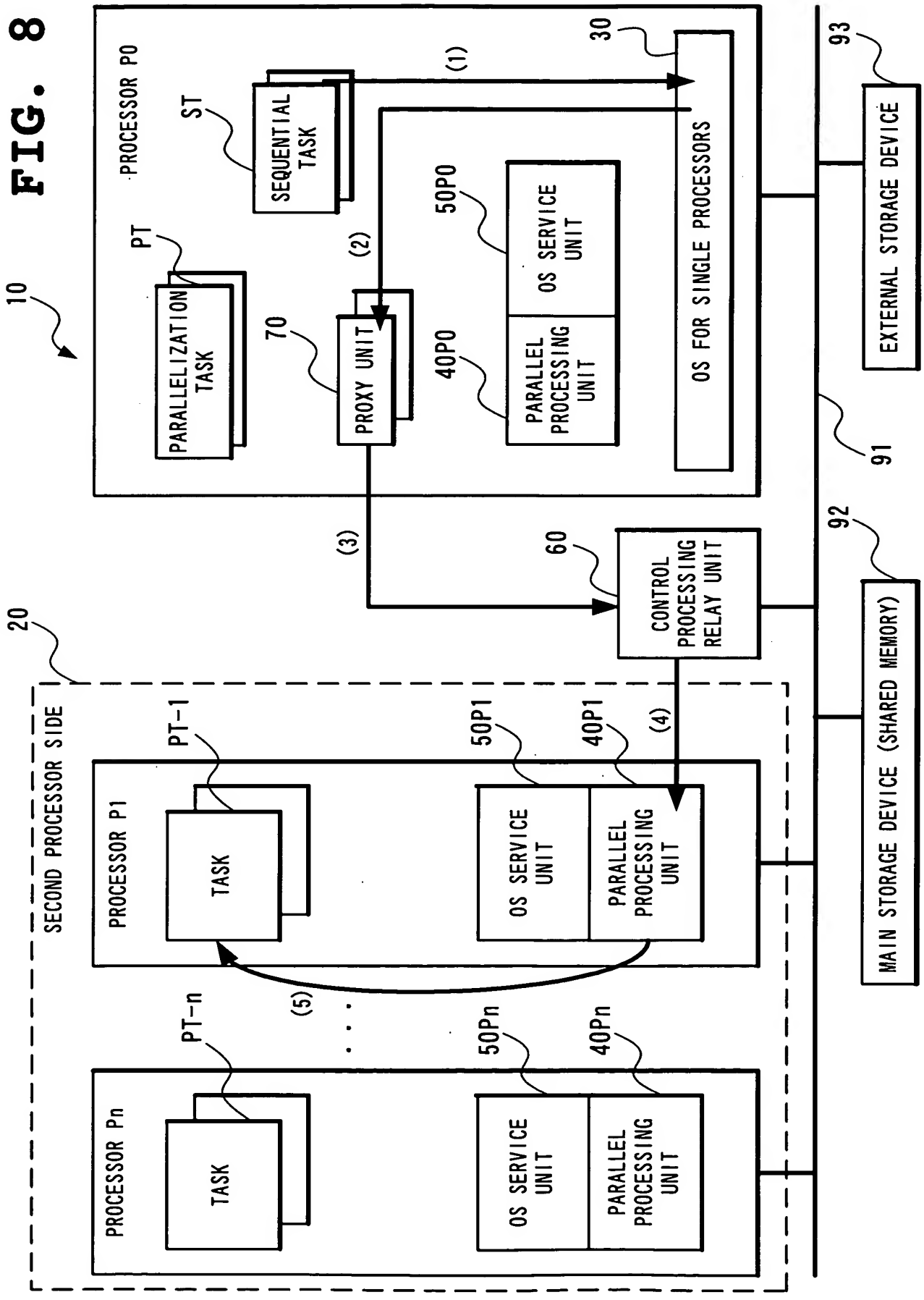

10
PROCESSOR P0
ST
SEQUENTIAL TASK
PT
PARALLELIZATION TASK
70
PROXY UNIT
50P0
OS SERVICE UNIT
40P0
PARALLEL PROCESSING UNIT
30
OS FOR SINGLE PROCESSORS
(1)
(2)
(3)
(4)
(5)
60
CONTROL PROCESSING RELAY UNIT
20
SECOND PROCESSOR SIDE
PROCESSOR P1
PT-1
TASK
50P1
OS SERVICE UNIT
40P1
PARALLEL PROCESSING UNIT
PROCESSOR Pn
PT-n
TASK
50Pn
OS SERVICE UNIT
40Pn
PARALLEL PROCESSING UNIT
91
92
93
EXTERNAL STORAGE DEVICE
MAIN STORAGE DEVICE (SHARED MEMORY)

FIG. 9

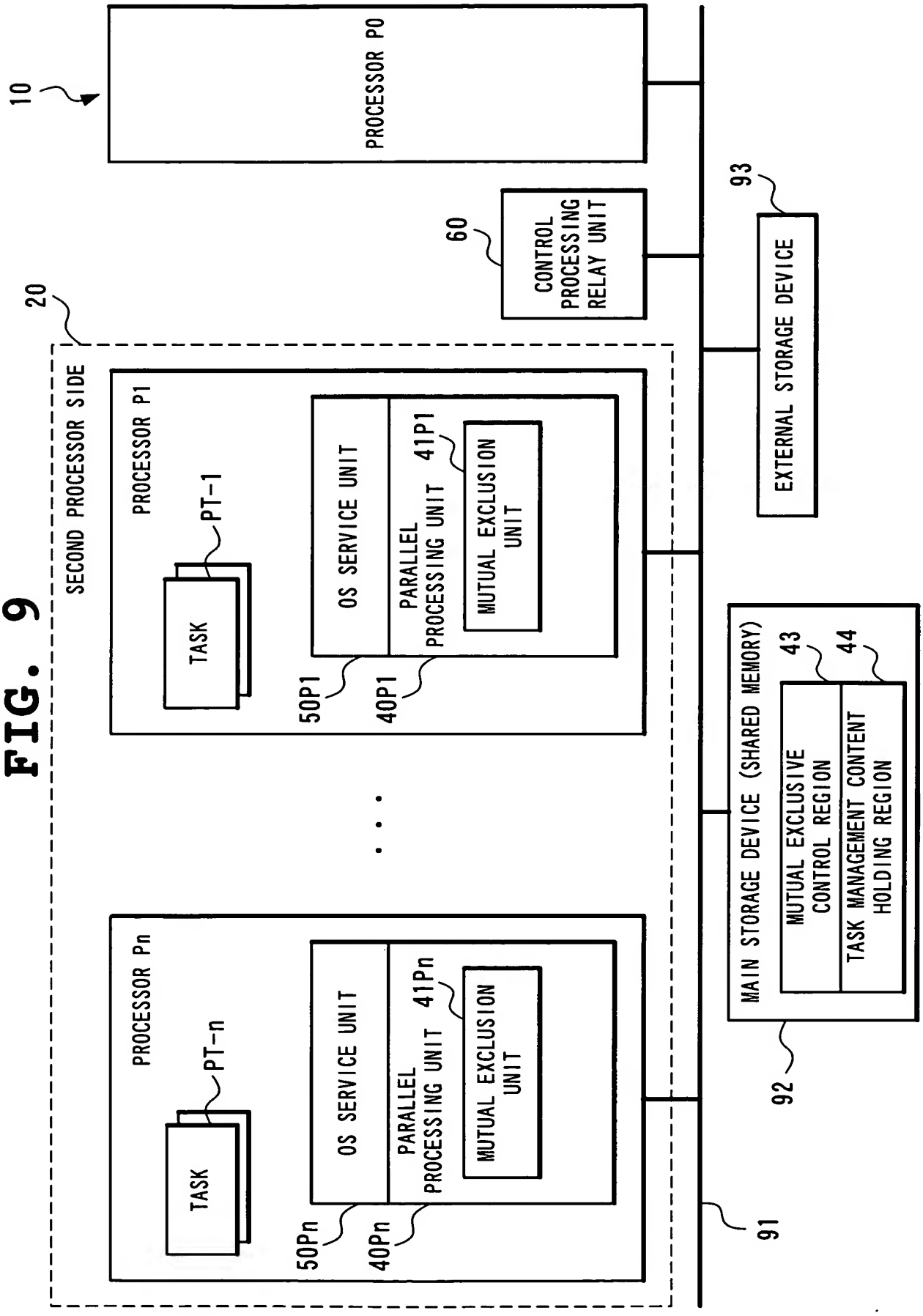

10
PROCESSOR P0
60
CONTROL PROCESSING RELAY UNIT
93
EXTERNAL STORAGE DEVICE
20
SECOND PROCESSOR SIDE
PROCESSOR P1
TASK
PT-1
OS SERVICE UNIT
PARALLEL PROCESSING UNIT
41P1
MUTUAL EXCLUSION UNIT
50P1
40P1
PROCESSOR Pn
TASK
PT-n
OS SERVICE UNIT
PARALLEL PROCESSING UNIT
41Pn
MUTUAL EXCLUSION UNIT
50Pn
40Pn
MAIN STORAGE DEVICE (SHARED MEMORY)
MUTUAL EXCLUSIVE CONTROL REGION
43
TASK MANAGEMENT CONTENT HOLDING REGION
44
92
91

FIG. 10

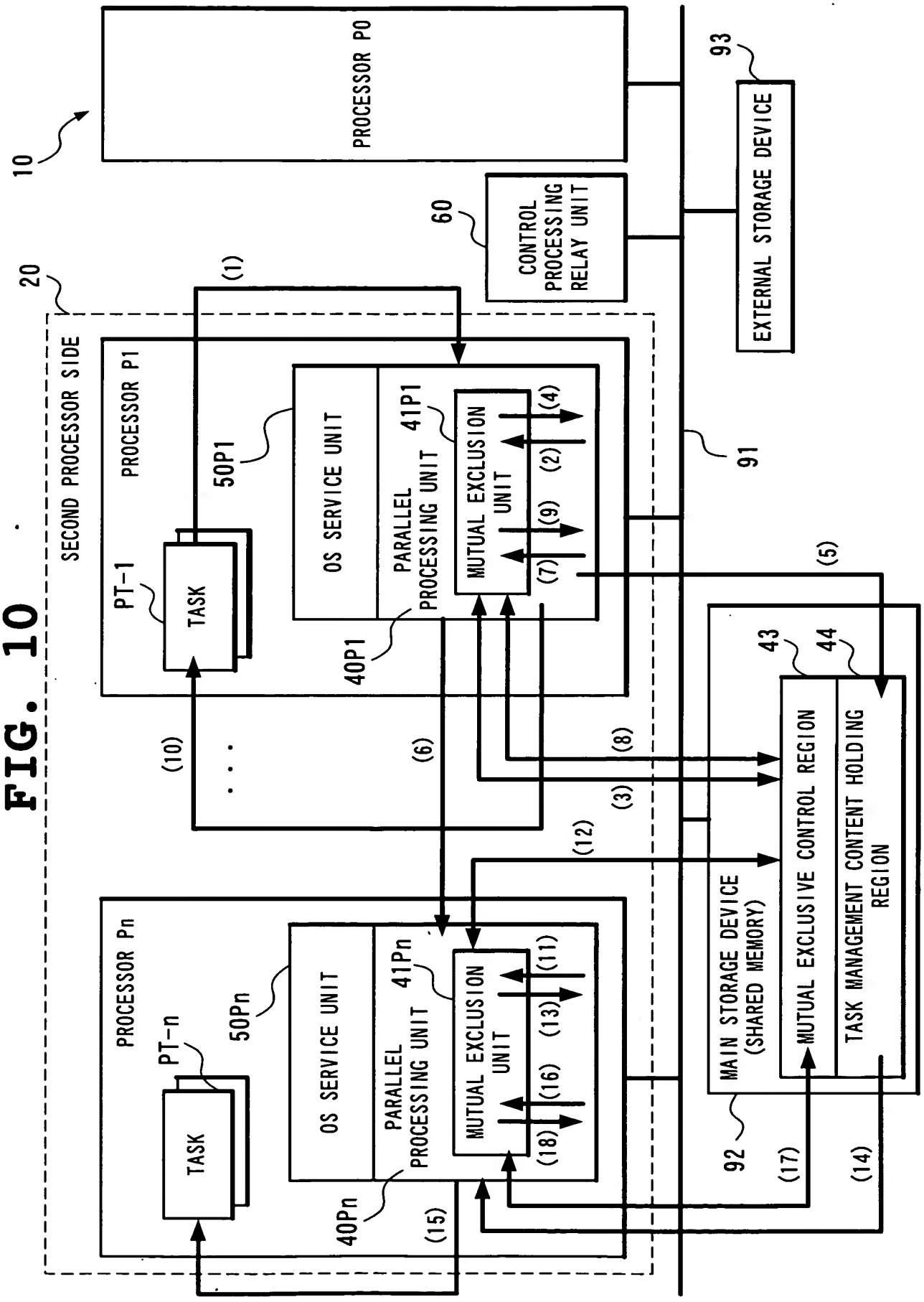

10
PROCESSOR P0
93
EXTERNAL STORAGE DEVICE
60
CONTROL PROCESSING RELAY UNIT
20
SECOND PROCESSOR SIDE
PROCESSOR P1
PT-1
TASK
50P1
OS SERVICE UNIT
PARALLEL PROCESSING UNIT
41P1
MUTUAL EXCLUSION UNIT
40P1
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
91
PROCESSOR Pn
PT-n
TASK
50Pn
OS SERVICE UNIT
PARALLEL PROCESSING UNIT
41Pn
MUTUAL EXCLUSION UNIT
40Pn
(11)
(12)
(13)
(14)
(15)
(16)
(17)
(18)
MAIN STORAGE DEVICE (SHARED MEMORY)
92
43
MUTUAL EXCLUSIVE CONTROL REGION
44
TASK MANAGEMENT CONTENT HOLDING REGION

FIG.11

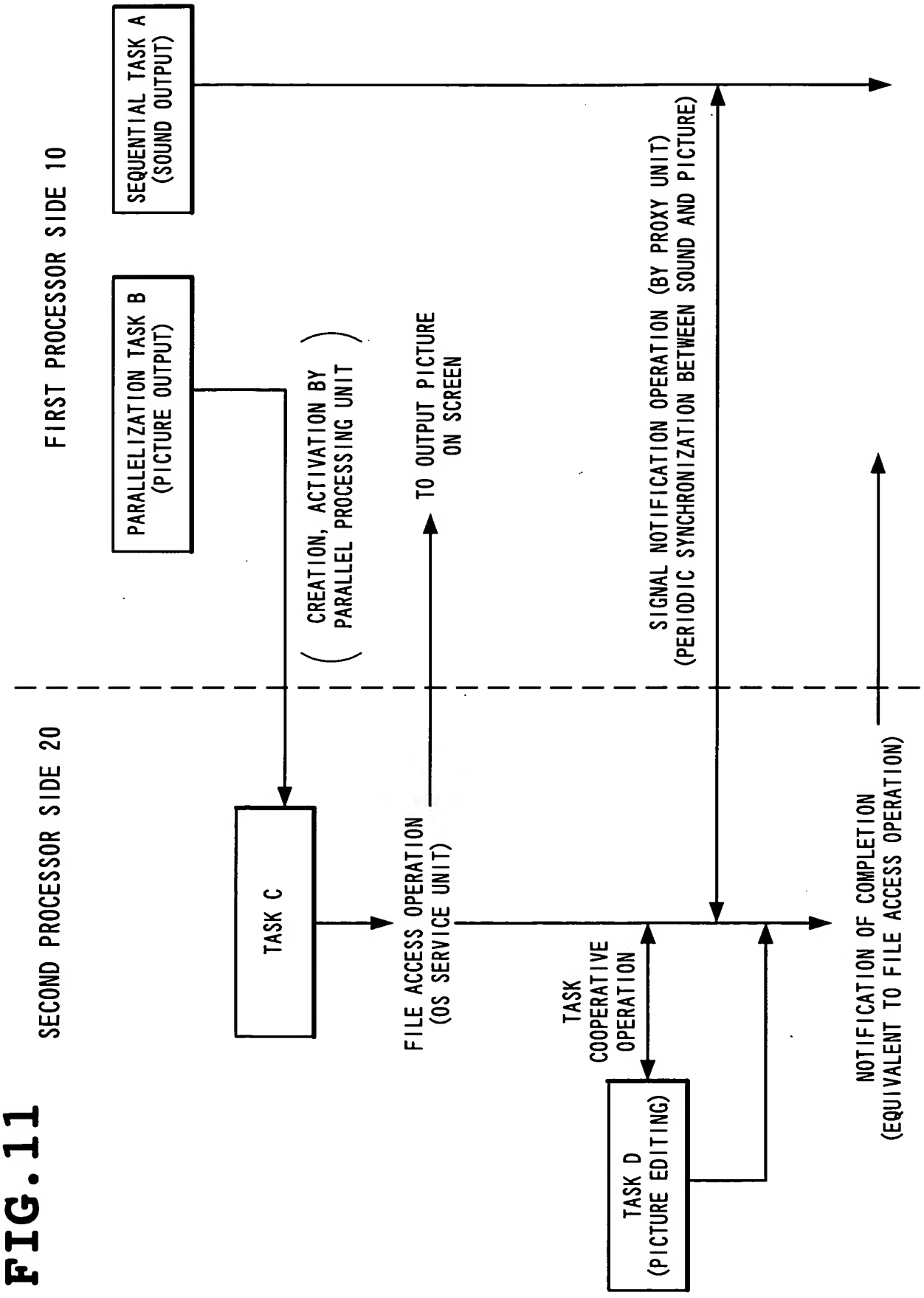

FIRST PROCESSOR SIDE 10
SECOND PROCESSOR SIDE 20
SEQUENTIAL TASK A (SOUND OUTPUT)
PARALLELIZATION TASK B (PICTURE OUTPUT)
CREATION, ACTIVATION BY PARALLEL PROCESSING UNIT
TO OUTPUT PICTURE ON SCREEN
SIGNAL NOTIFICATION OPERATION (BY PROXY UNIT) (PERIODIC SYNCHRONIZATION BETWEEN SOUND AND PICTURE)
TASK C
FILE ACCESS OPERATION (OS SERVICE UNIT)
TASK COOPERATIVE OPERATION
TASK D (PICTURE EDITING)
NOTIFICATION OF COMPLETION (EQUIVALENT TO FILE ACCESS OPERATION)

FIG. 12

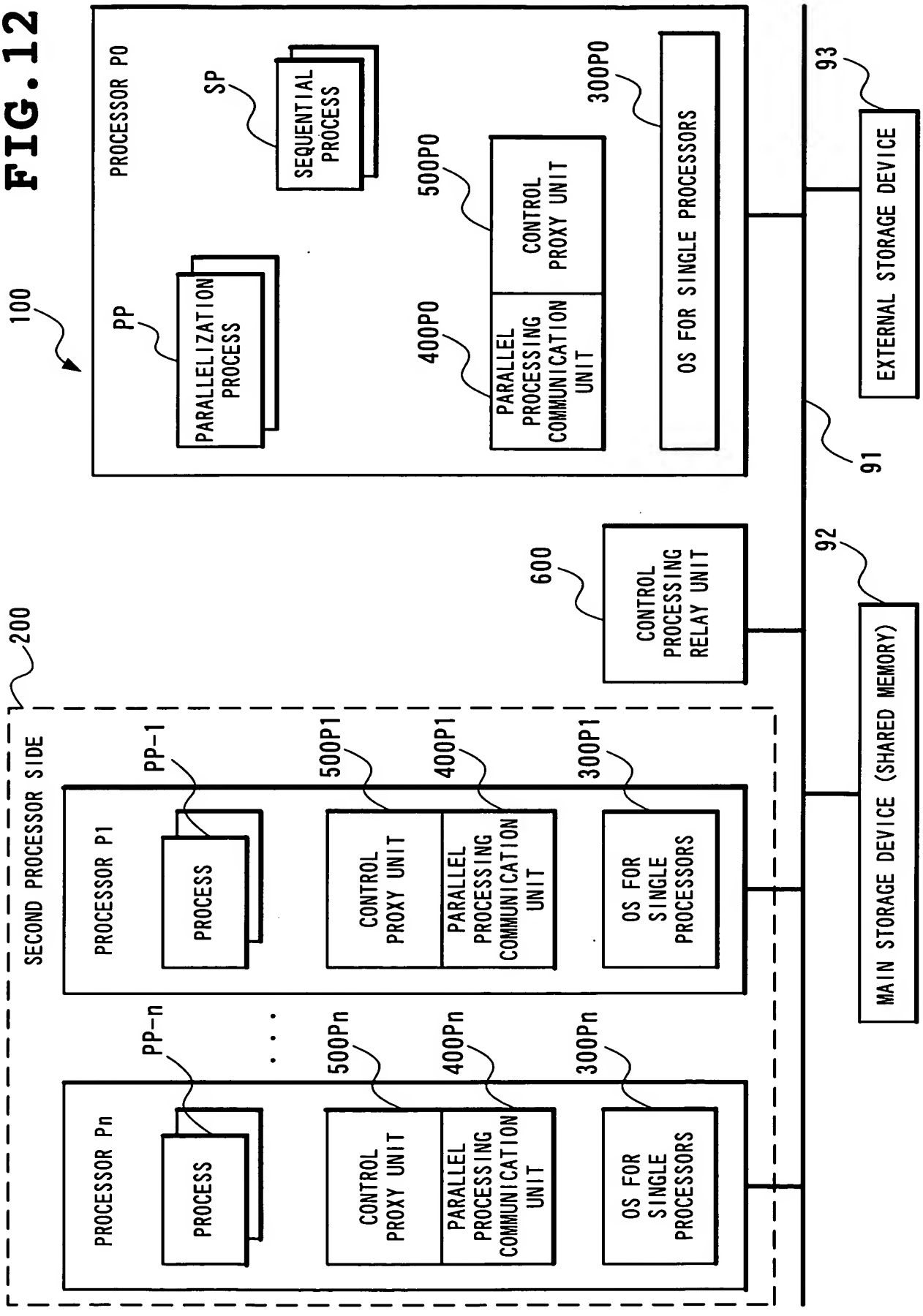

100
PROCESSOR P0
PP
PARALLELIZATION PROCESS
SP
SEQUENTIAL PROCESS
500P0
CONTROL PROXY UNIT
400P0
PARALLEL PROCESSING COMMUNICATION UNIT
300P0
OS FOR SINGLE PROCESSORS
93
EXTERNAL STORAGE DEVICE
91
600
CONTROL PROCESSING RELAY UNIT
92
MAIN STORAGE DEVICE (SHARED MEMORY)
200
SECOND PROCESSOR SIDE
PROCESSOR P1
PP-1
PROCESS
500P1
CONTROL PROXY UNIT
400P1
PARALLEL PROCESSING COMMUNICATION UNIT
300P1
OS FOR SINGLE PROCESSORS
PROCESSOR Pn
PP-n
PROCESS
500Pn
CONTROL PROXY UNIT
400Pn
PARALLEL PROCESSING COMMUNICATION UNIT
300Pn
OS FOR SINGLE PROCESSORS

FIG. 13

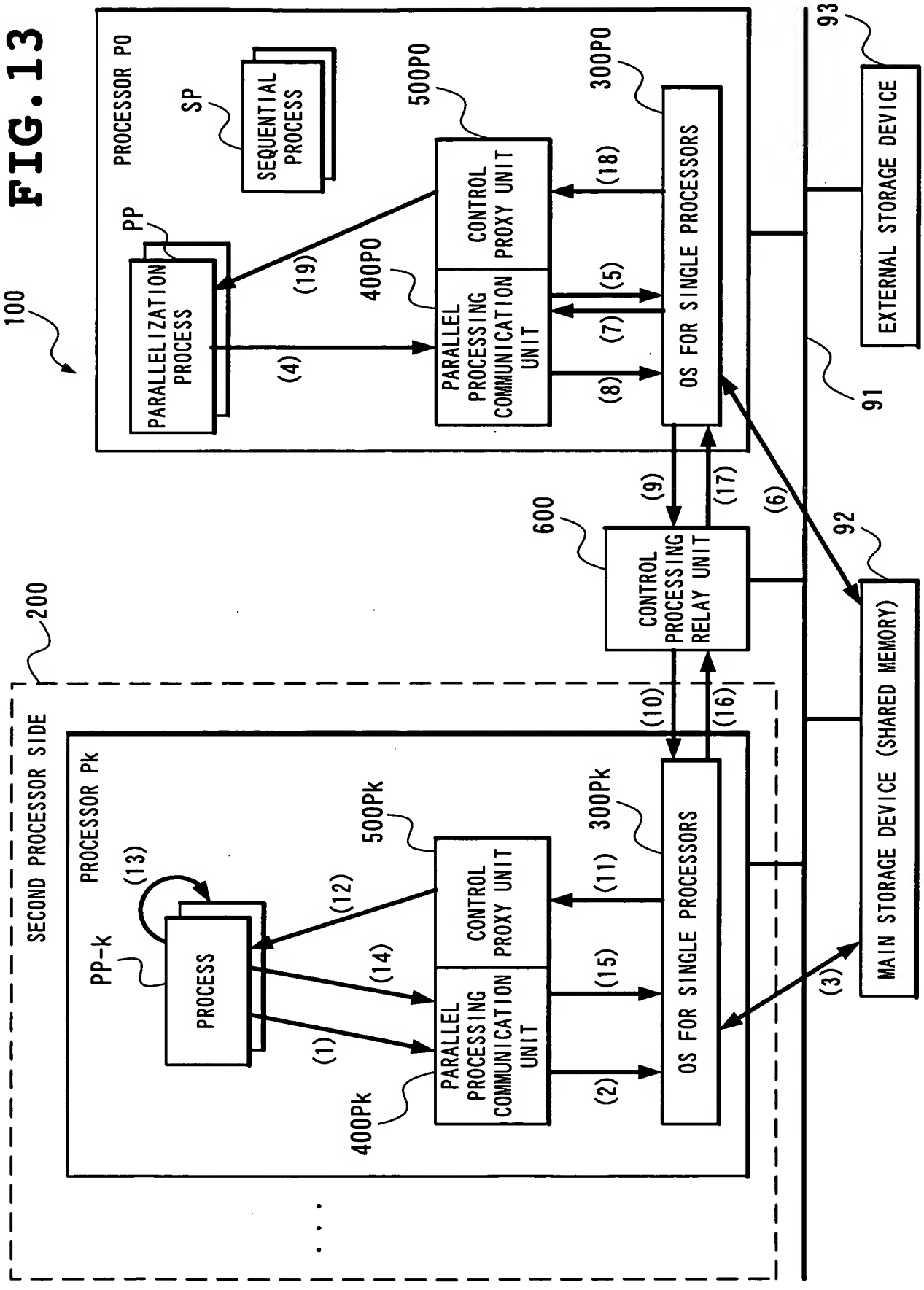

100
PROCESSOR P0
SP
SEQUENTIAL PROCESS
PP
PARALLELIZATION PROCESS
500P0
CONTROL PROXY UNIT
400P0
PARALLEL PROCESSING COMMUNICATION UNIT
300P0
OS FOR SINGLE PROCESSORS
(4)
(5)
(7)
(8)
(18)
(19)
91
93
EXTERNAL STORAGE DEVICE
600
CONTROL PROCESSING RELAY UNIT
(9)
(17)
(6)
92
MAIN STORAGE DEVICE (SHARED MEMORY)
(3)
200
SECOND PROCESSOR SIDE
(10)
(16)
PROCESSOR Pk
PP-k
PROCESS
(13)
500Pk
CONTROL PROXY UNIT
300Pk
OS FOR SINGLE PROCESSORS
(11)
(12)
(14)
(15)
(1)
(2)
400Pk
PARALLEL PROCESSING COMMUNICATION UNIT

FIG. 14

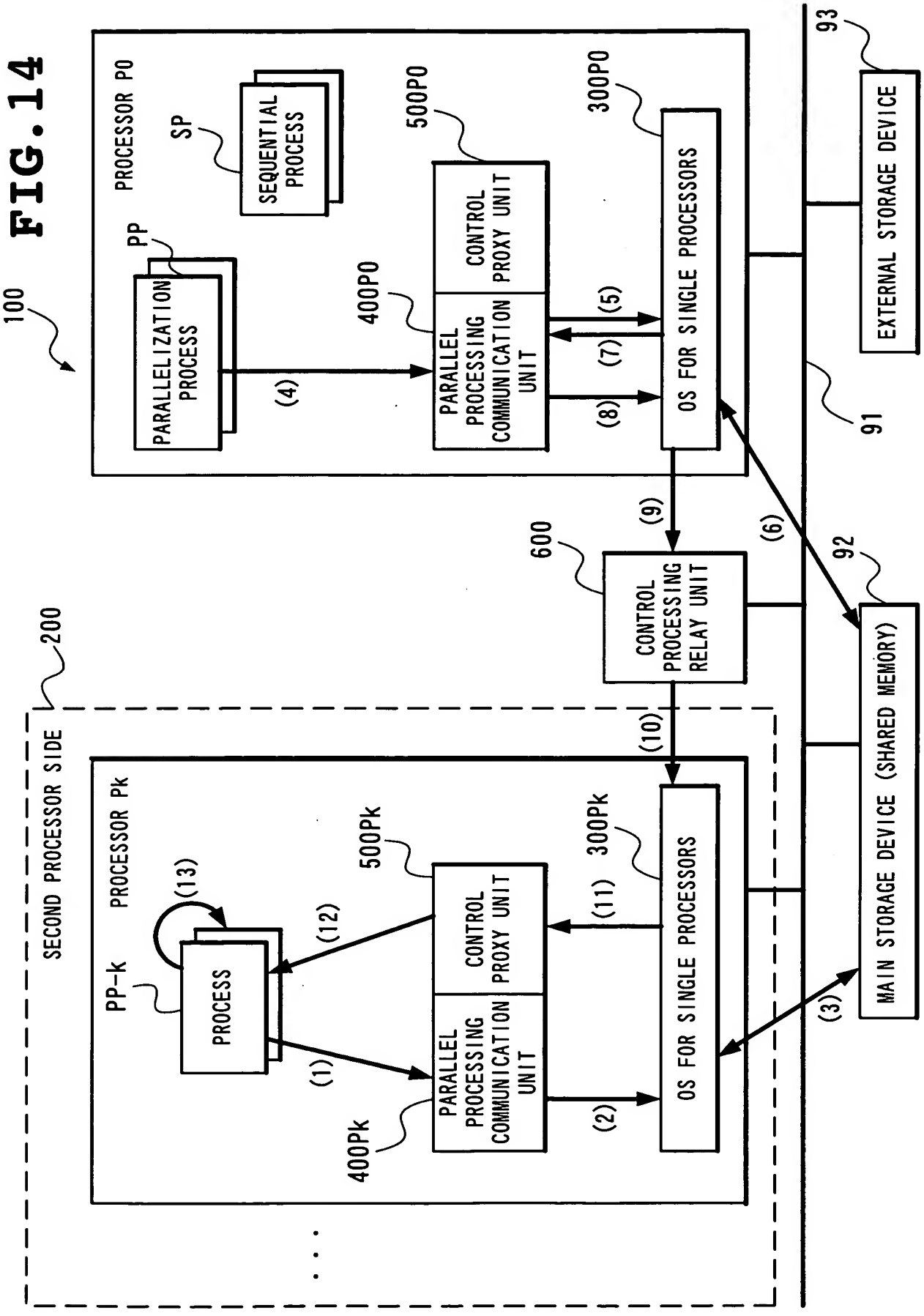

100
PROCESSOR P0
SP
SEQUENTIAL PROCESS
PP
PARALLELIZATION PROCESS
400P0
500P0
CONTROL PROXY UNIT
PARALLEL PROCESSING COMMUNICATION UNIT
300P0
OS FOR SINGLE PROCESSORS
(4)
(5)
(7)
(8)
91
93
EXTERNAL STORAGE DEVICE
(9)
600
CONTROL PROCESSING RELAY UNIT
(6)
92
MAIN STORAGE DEVICE (SHARED MEMORY)
(3)
(10)
200
SECOND PROCESSOR SIDE
PROCESSOR Pk
PP-k
PROCESS
(13)
(12)
500Pk
CONTROL PROXY UNIT
(11)
300Pk
OS FOR SINGLE PROCESSORS
(1)
400Pk
PARALLEL PROCESSING COMMUNICATION UNIT
(2)

FIG.15

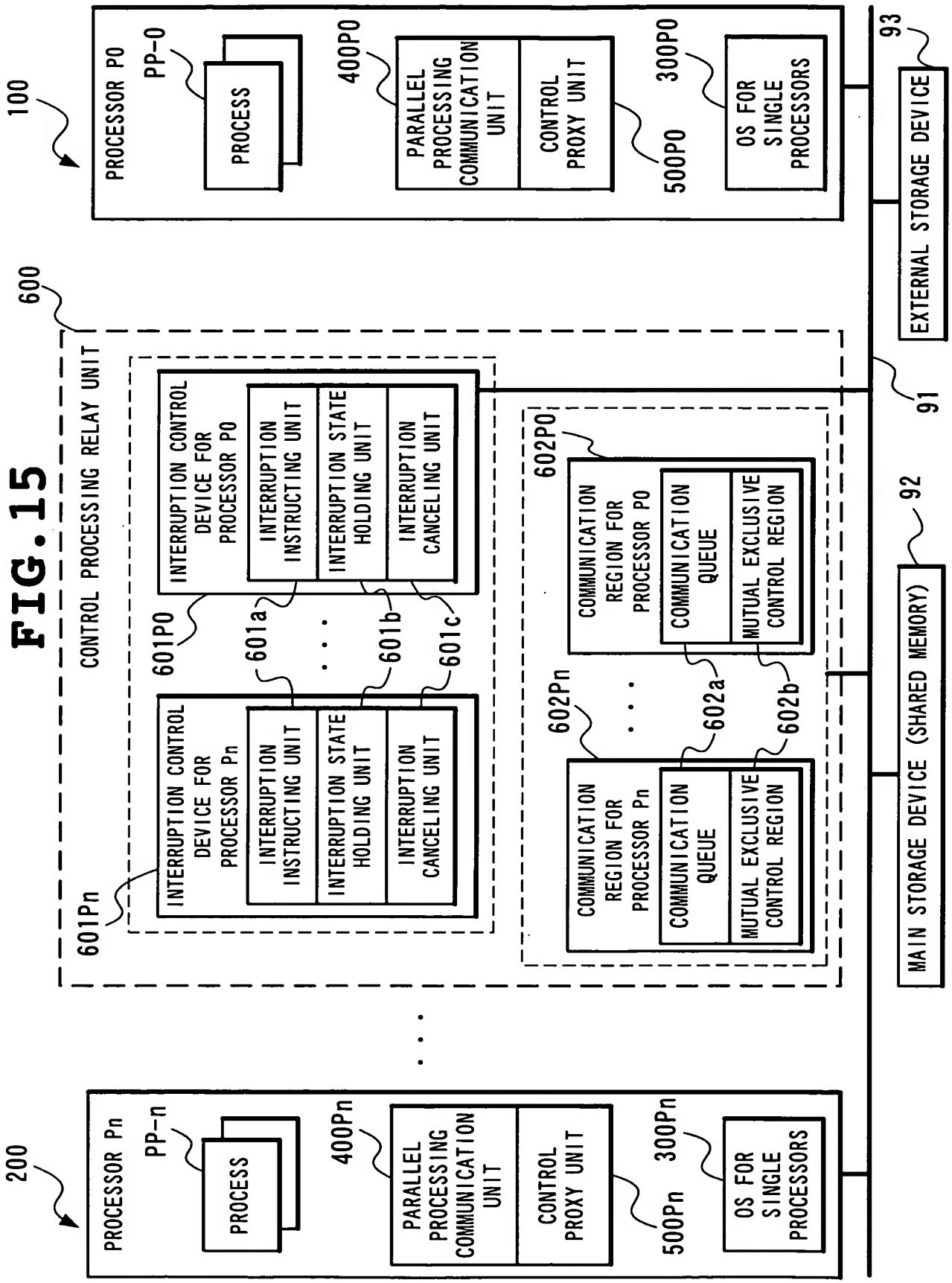

100
PROCESSOR P0
PP-0
PROCESS
400P0
PARALLEL PROCESSING COMMUNICATION UNIT
CONTROL PROXY UNIT
500P0
300P0
OS FOR SINGLE PROCESSORS
93
EXTERNAL STORAGE DEVICE
600
CONTROL PROCESSING RELAY UNIT
INTERRUPTION CONTROL DEVICE FOR PROCESSOR P0
INTERRUPTION INSTRUCTING UNIT
INTERRUPTION STATE HOLDING UNIT
INTERRUPTION CANCELING UNIT
601P0
601a
601b
601c
INTERRUPTION CONTROL DEVICE FOR PROCESSOR Pn
601Pn
602P0
COMMUNICATION REGION FOR PROCESSOR P0
COMMUNICATION QUEUE
MUTUAL EXCLUSIVE CONTROL REGION
602a
602b
602Pn
COMMUNICATION REGION FOR PROCESSOR Pn
91
92
MAIN STORAGE DEVICE (SHARED MEMORY)
200
PROCESSOR Pn
PP-n
PROCESS
400Pn
PARALLEL PROCESSING COMMUNICATION UNIT
CONTROL PROXY UNIT
500Pn
300Pn
OS FOR SINGLE PROCESSORS

FIG. 16

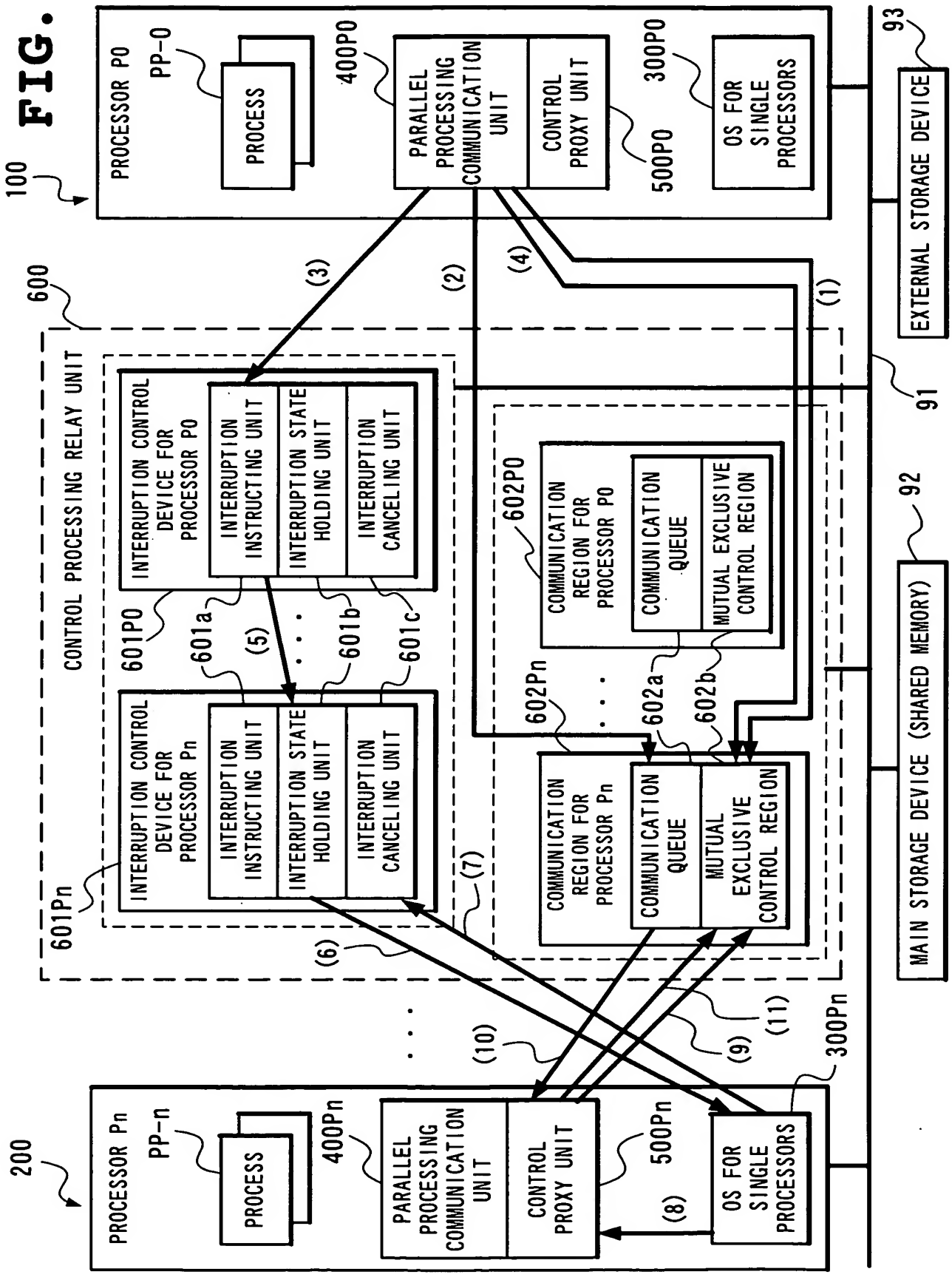

100
PROCESSOR P0
PP-0
PROCESS
400P0
PARALLEL PROCESSING COMMUNICATION UNIT
CONTROL PROXY UNIT
500P0
300P0
OS FOR SINGLE PROCESSORS
93
EXTERNAL STORAGE DEVICE
600
CONTROL PROCESSING RELAY UNIT
INTERRUPTION CONTROL DEVICE FOR PROCESSOR P0
INTERRUPTION INSTRUCTING UNIT
INTERRUPTION STATE HOLDING UNIT
INTERRUPTION CANCELING UNIT
601P0
601a
601b
601c
INTERRUPTION CONTROL DEVICE FOR PROCESSOR Pn
601Pn
COMMUNICATION REGION FOR PROCESSOR P0
602P0
COMMUNICATION QUEUE
MUTUAL EXCLUSIVE CONTROL REGION
602a
602b
COMMUNICATION REGION FOR PROCESSOR Pn
602Pn
MUTUAL EXCLUSIVE CONTROL REGION
91
92
MAIN STORAGE DEVICE (SHARED MEMORY)
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
200
PROCESSOR Pn
PP-n
PROCESS
400Pn
PARALLEL PROCESSING COMMUNICATION UNIT
CONTROL PROXY UNIT
500Pn
300Pn
OS FOR SINGLE PROCESSORS

FIG. 17

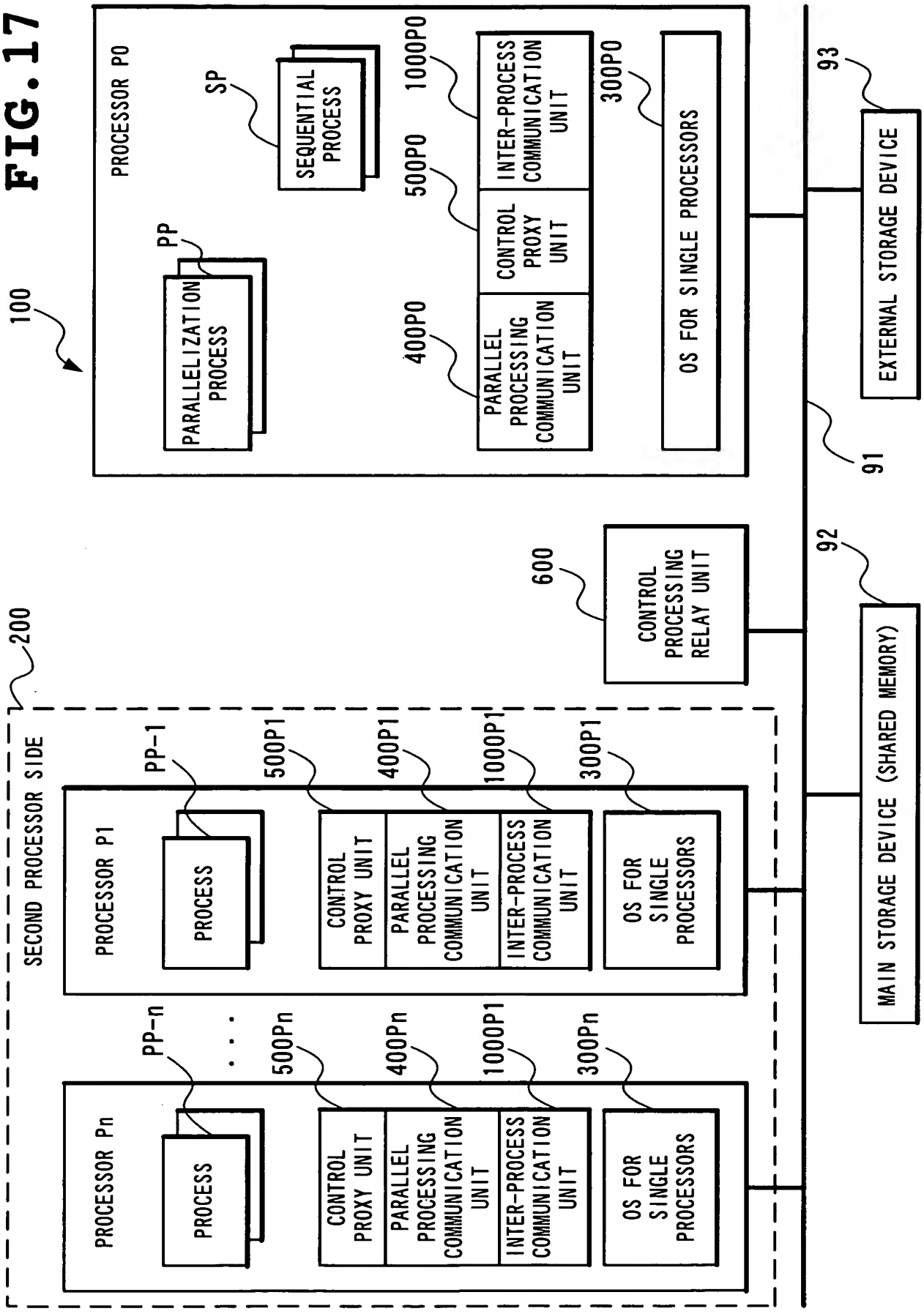

100
PROCESSOR P0
SP
SEQUENTIAL PROCESS
PP
PARALLELIZATION PROCESS
500P0
1000P0
CONTROL PROXY UNIT
INTER-PROCESS COMMUNICATION UNIT
400P0
PARALLEL PROCESSING COMMUNICATION UNIT
300P0
OS FOR SINGLE PROCESSORS
93
EXTERNAL STORAGE DEVICE
91
600
CONTROL PROCESSING RELAY UNIT
92
MAIN STORAGE DEVICE (SHARED MEMORY)
200
SECOND PROCESSOR SIDE
PROCESSOR P1
PP-1
PROCESS
500P1
CONTROL PROXY UNIT
400P1
PARALLEL PROCESSING COMMUNICATION UNIT
1000P1
INTER-PROCESS COMMUNICATION UNIT
300P1
OS FOR SINGLE PROCESSORS
PROCESSOR Pn
PP-n
PROCESS
500Pn
CONTROL PROXY UNIT
400Pn
PARALLEL PROCESSING COMMUNICATION UNIT
1000P1
INTER-PROCESS COMMUNICATION UNIT
300Pn
OS FOR SINGLE PROCESSORS

FIG.18

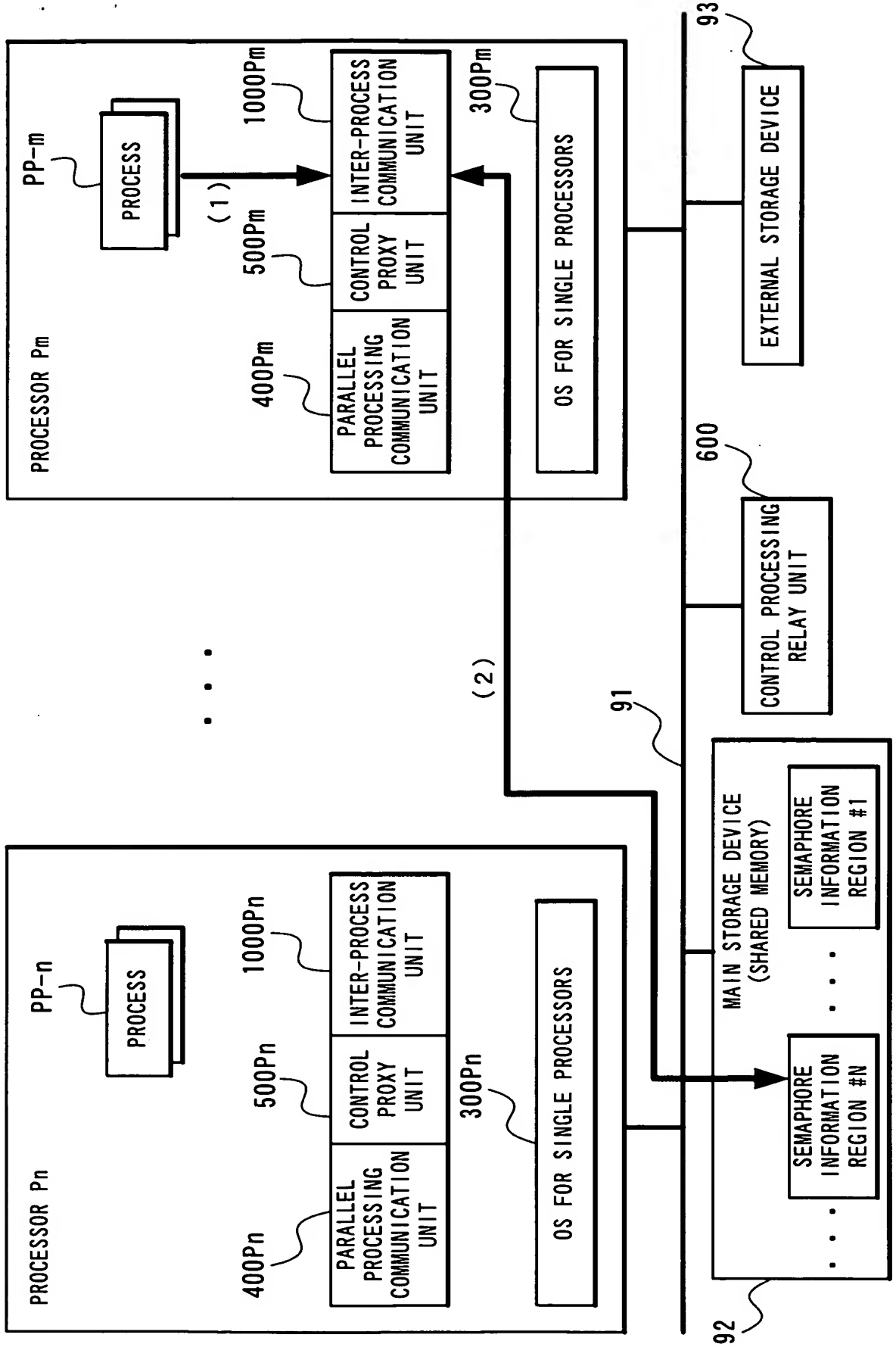

(UP/DOWN OPERATION BY SEMAPHORE SYSTEM)
PROCESSOR Pm
PP-m
PROCESS
(1)
1000Pm
INTER-PROCESS COMMUNICATION UNIT
500Pm
CONTROL PROXY UNIT
400Pm
PARALLEL PROCESSING COMMUNICATION UNIT
300Pm
OS FOR SINGLE PROCESSORS
PROCESSOR Pn
PP-n
PROCESS
1000Pn
INTER-PROCESS COMMUNICATION UNIT
500Pn
CONTROL PROXY UNIT
400Pn
PARALLEL PROCESSING COMMUNICATION UNIT
300Pn
OS FOR SINGLE PROCESSORS
(2)
91
92
93
600
EXTERNAL STORAGE DEVICE
CONTROL PROCESSING RELAY UNIT
MAIN STORAGE DEVICE (SHARED MEMORY)
SEMAPHORE INFORMATION REGION #1
SEMAPHORE INFORMATION REGION #N

FIG.19

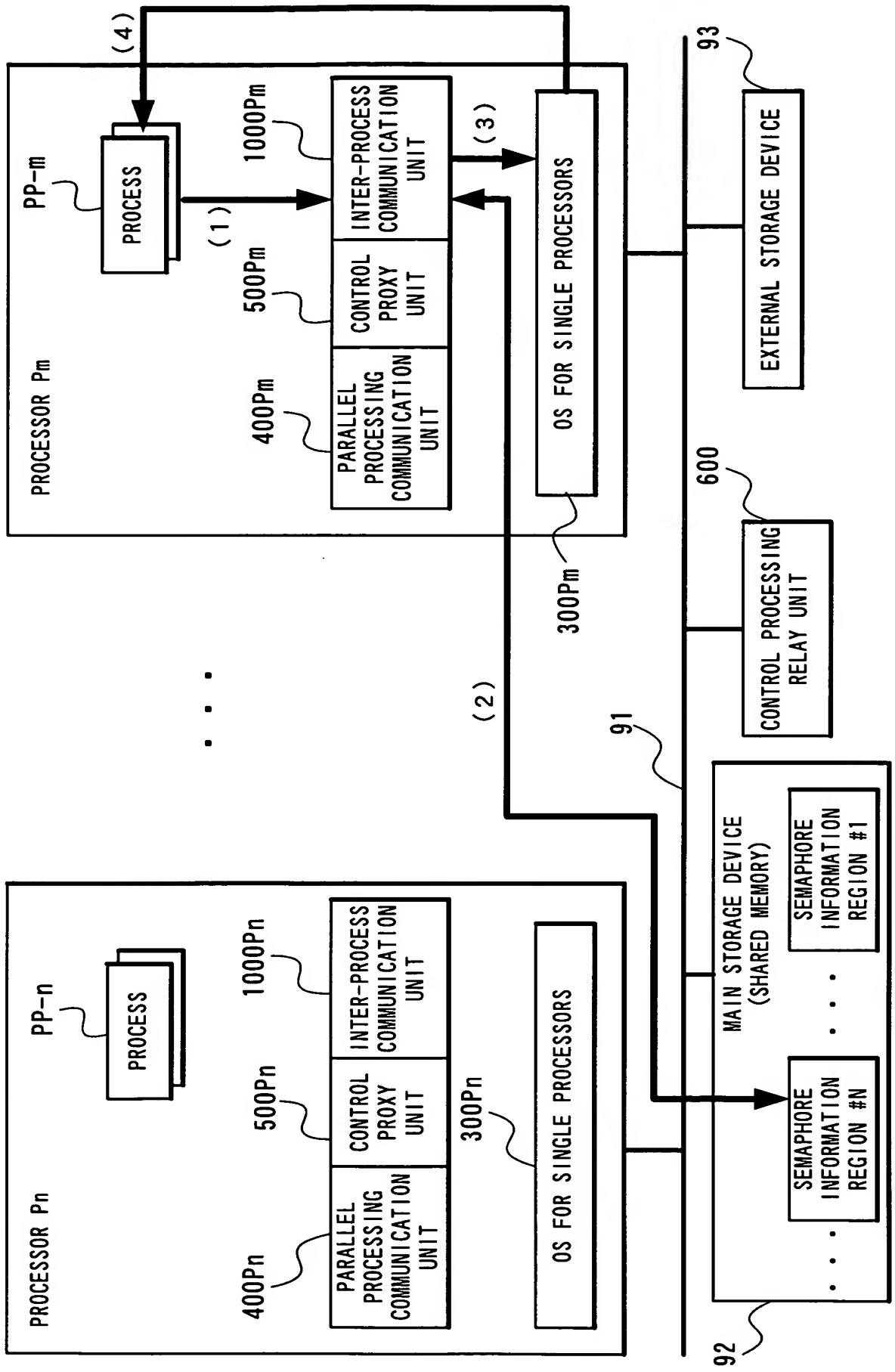

(DOWN OPERATION BY SEMAPHORE)
PROCESSOR Pm
PP-m
PROCESS
(1)
1000Pm
INTER-PROCESS COMMUNICATION UNIT
500Pm
CONTROL PROXY UNIT
400Pm
PARALLEL PROCESSING COMMUNICATION UNIT
(3)
(4)
OS FOR SINGLE PROCESSORS
300Pm
(2)
PROCESSOR Pn
PP-n
PROCESS
1000Pn
INTER-PROCESS COMMUNICATION UNIT
500Pn
CONTROL PROXY UNIT
400Pn
PARALLEL PROCESSING COMMUNICATION UNIT
300Pn
OS FOR SINGLE PROCESSORS
91
MAIN STORAGE DEVICE (SHARED MEMORY)
SEMAPHORE INFORMATION REGION #1
SEMAPHORE INFORMATION REGION #N
92
93
EXTERNAL STORAGE DEVICE
600
CONTROL PROCESSING RELAY UNIT

FIG.20

(UP OPERATION BY SEMAPHORE SYSTEM ON THE SAME PROCESSOR)

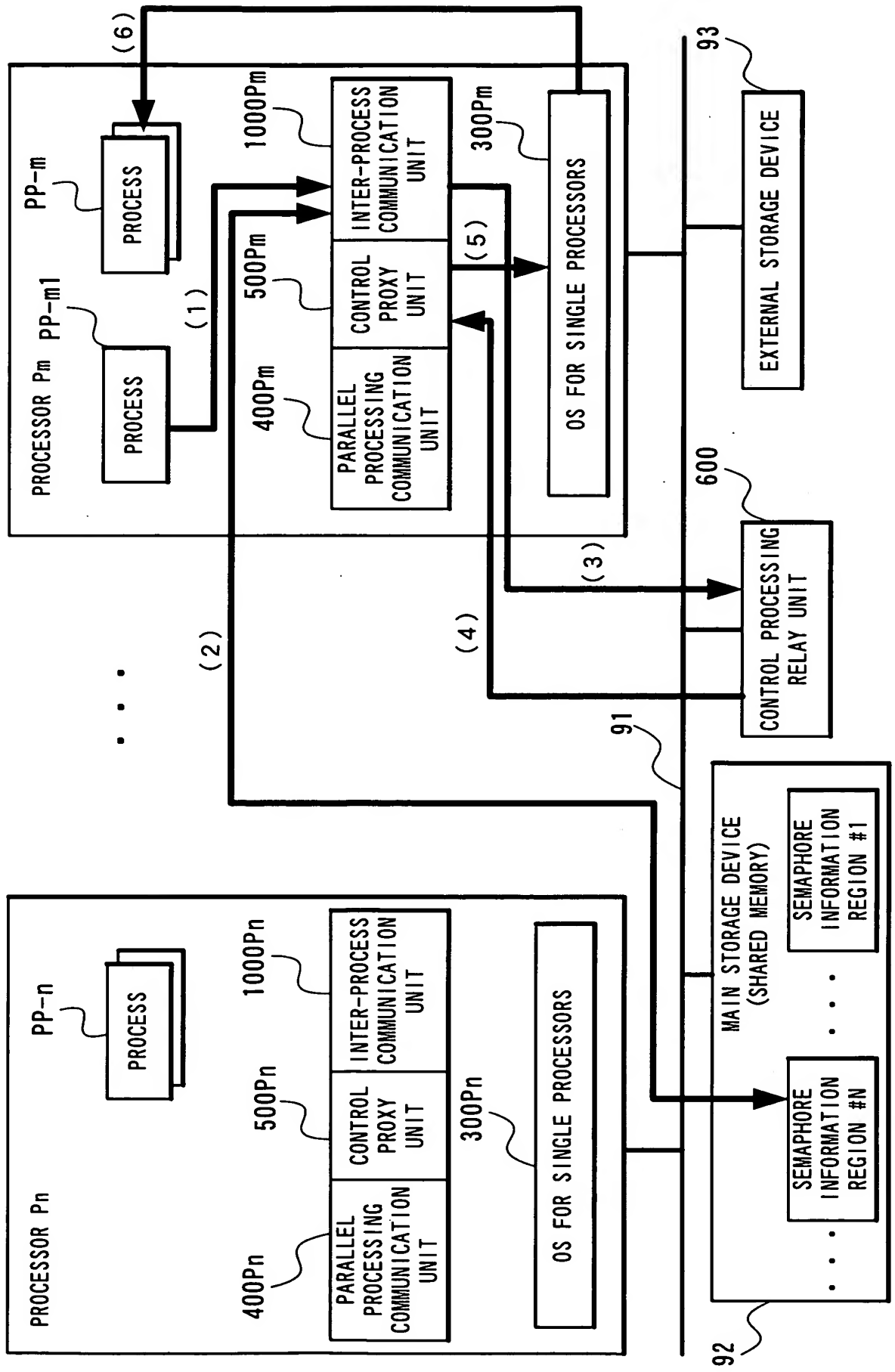


FIG.21 (UP OPERATION BY SEMAPHORE SYSTEM BETWEEN DIFFERENT PROCESSORS)

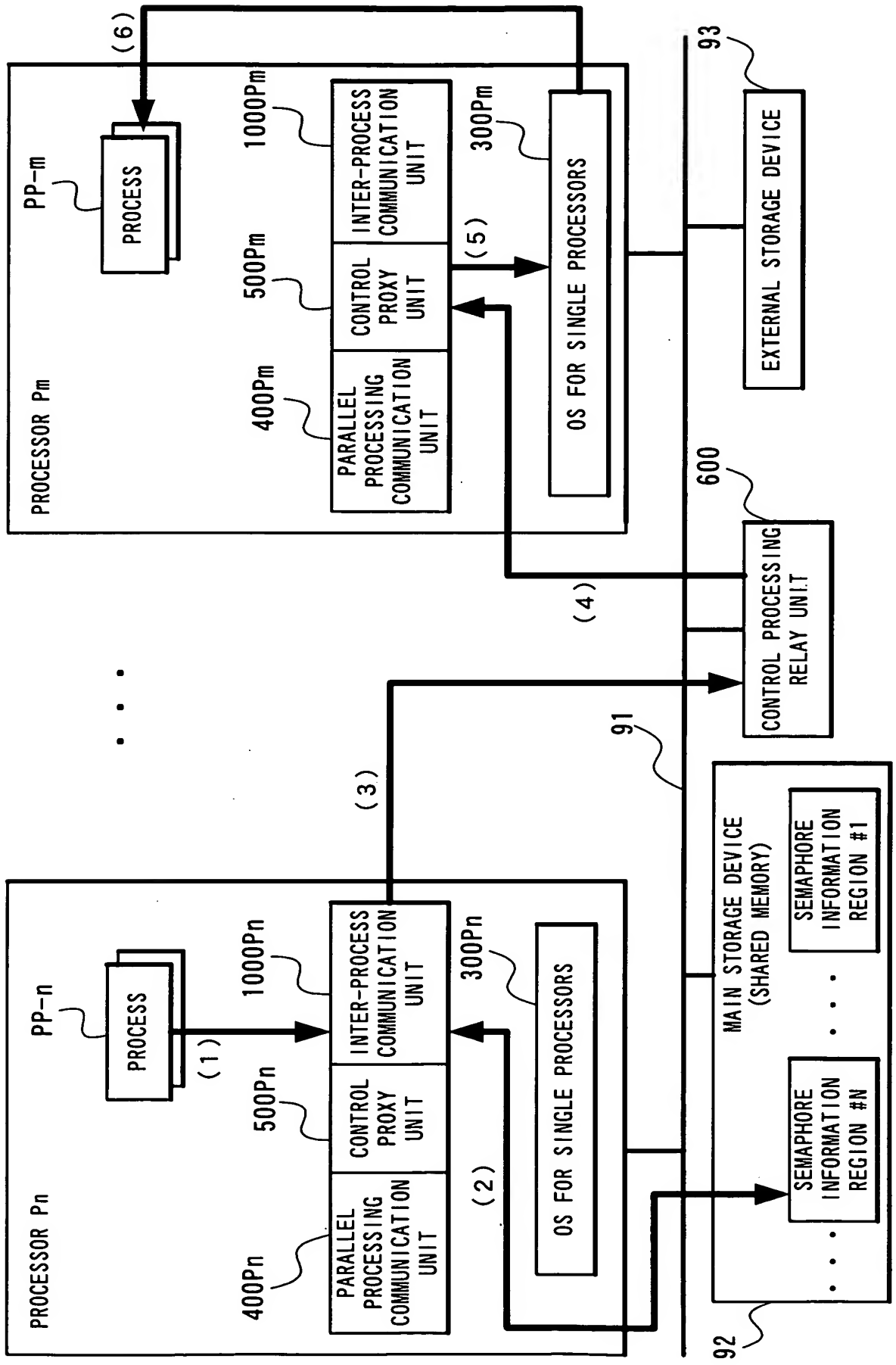


FIG.22

(MESSAGE RECEPTION OPERATION BY MESSAGE QUEUE SYSTEM)

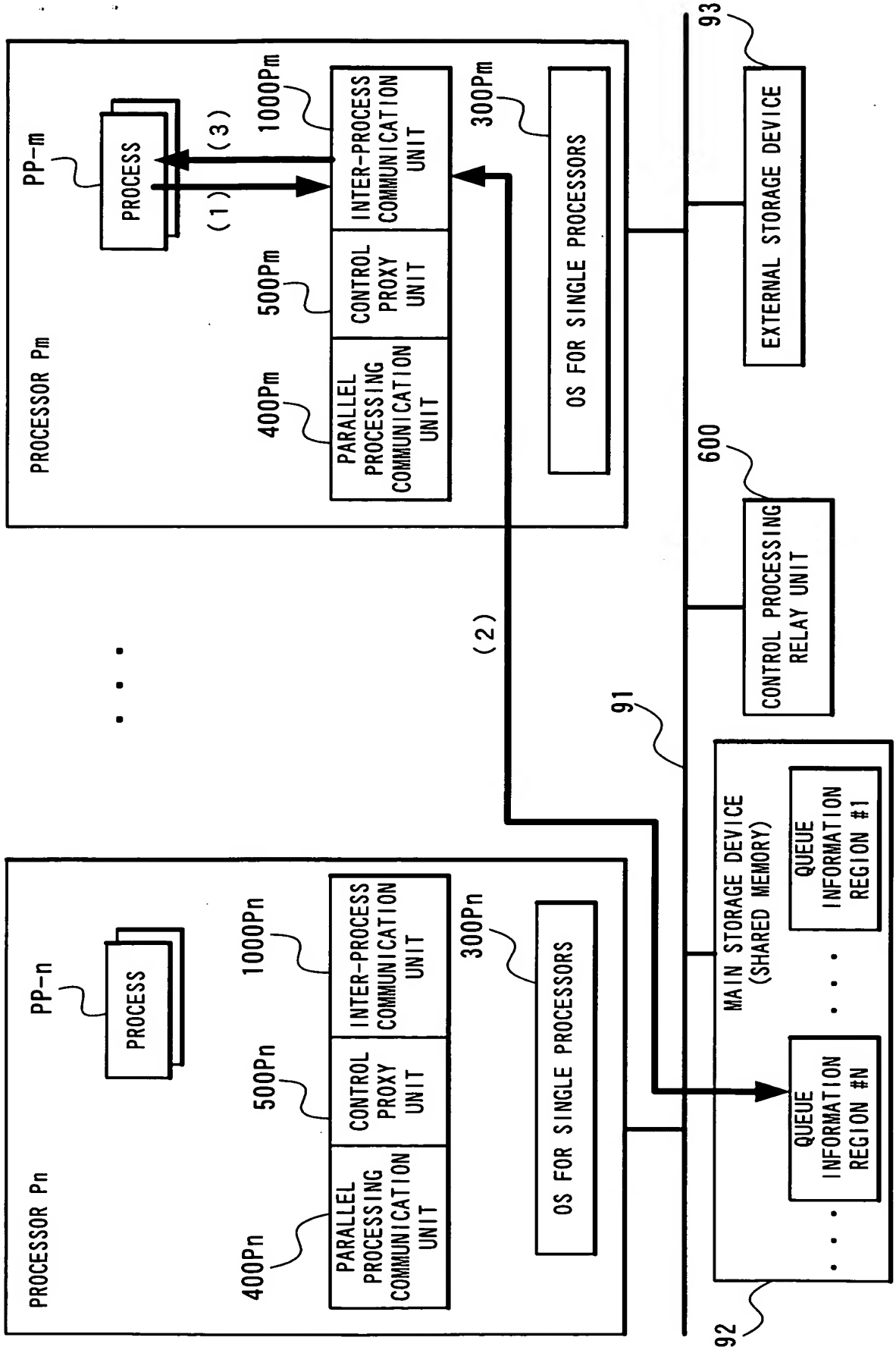


FIG.23

(MESSAGE RECEPTION OPERATION BY MESSAGE QUEUE SYSTEM)

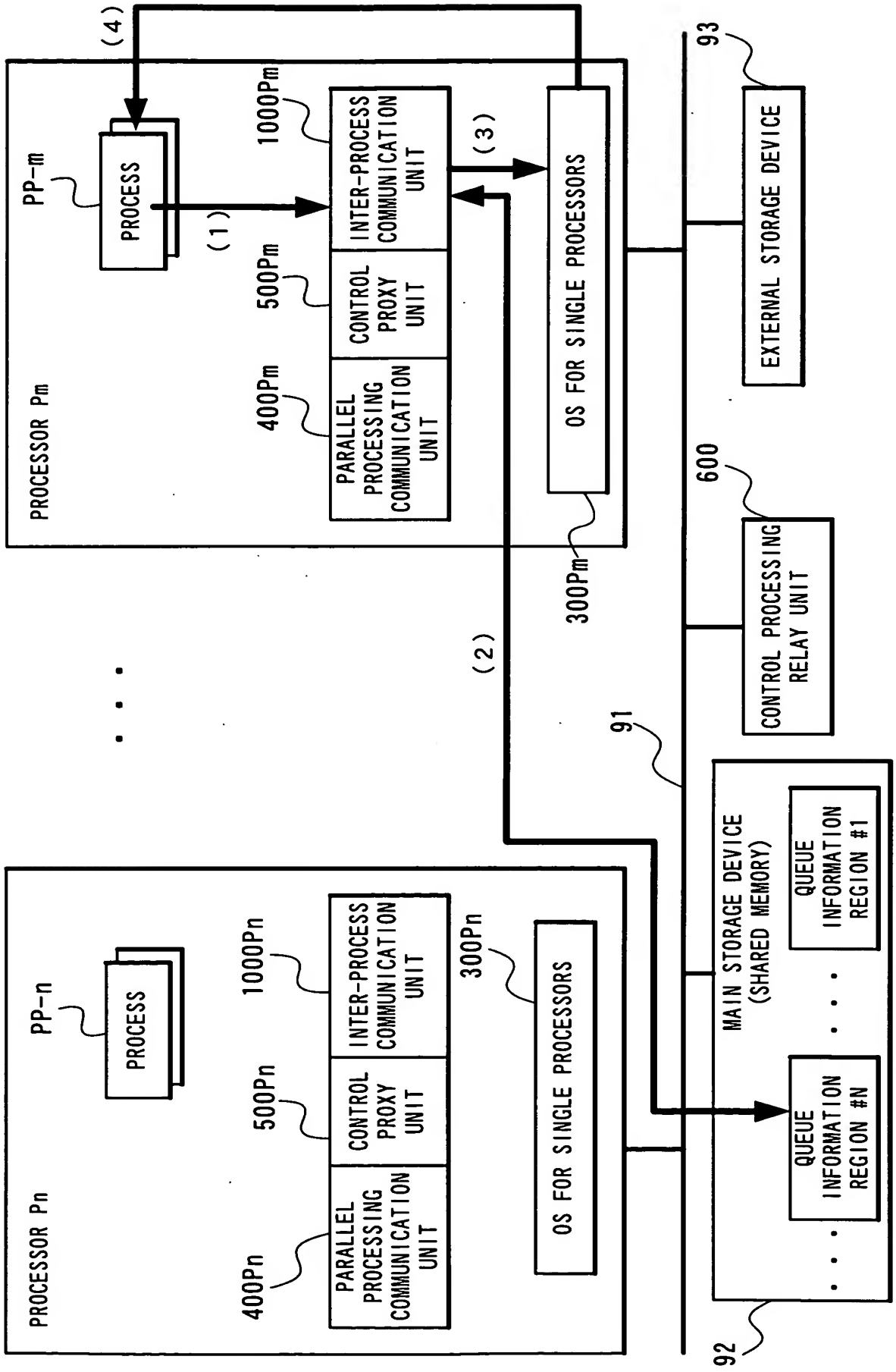


FIG.24 (MESSAGE TRANSMISSION OPERATION BY MESSAGE QUEUE SYSTEM)

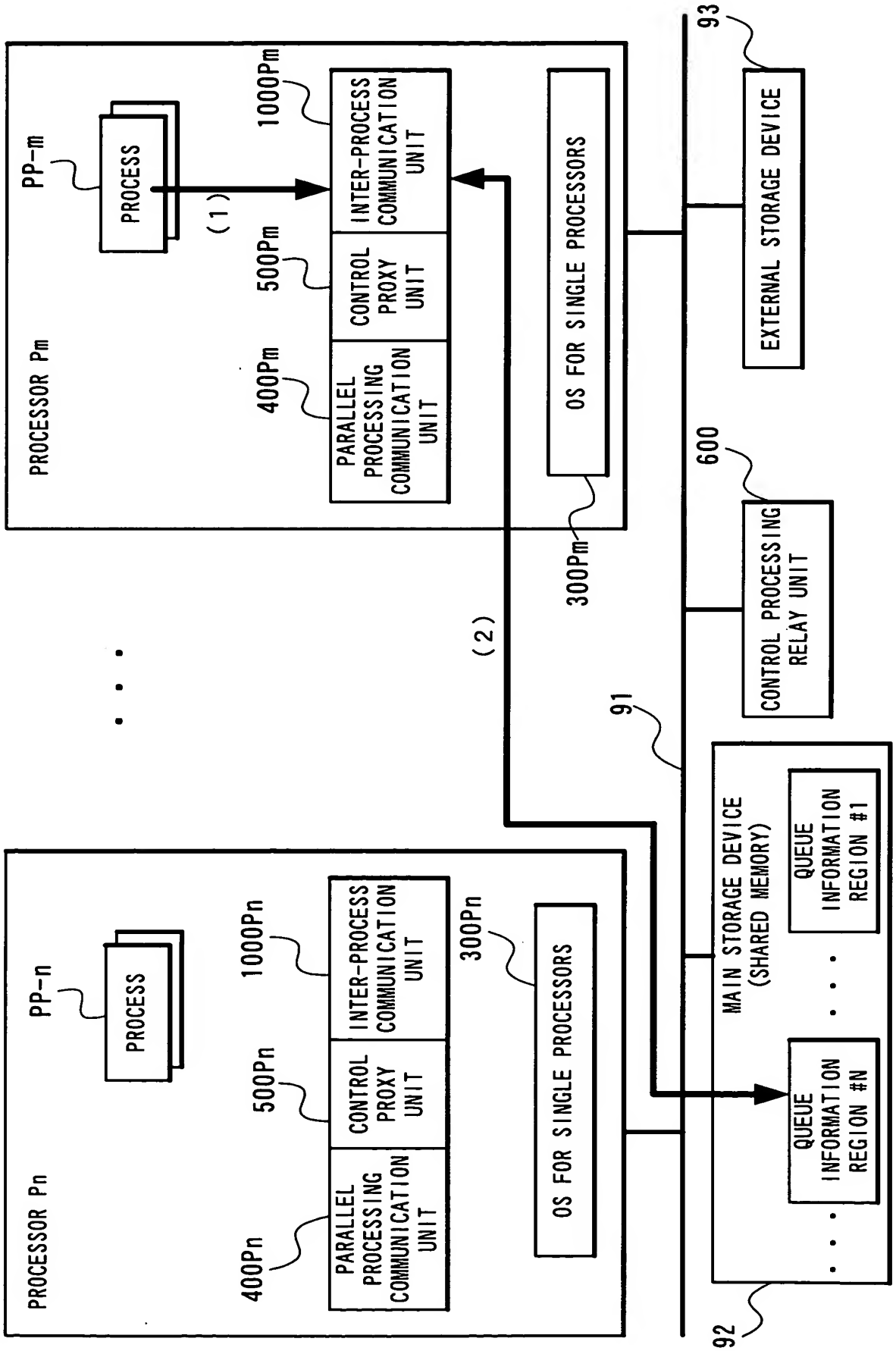


FIG.25 (MESSAGE TRANSMISSION OPERATION BY MESSAGE QUEUE SYSTEM IN THE SAME PROCESSOR)

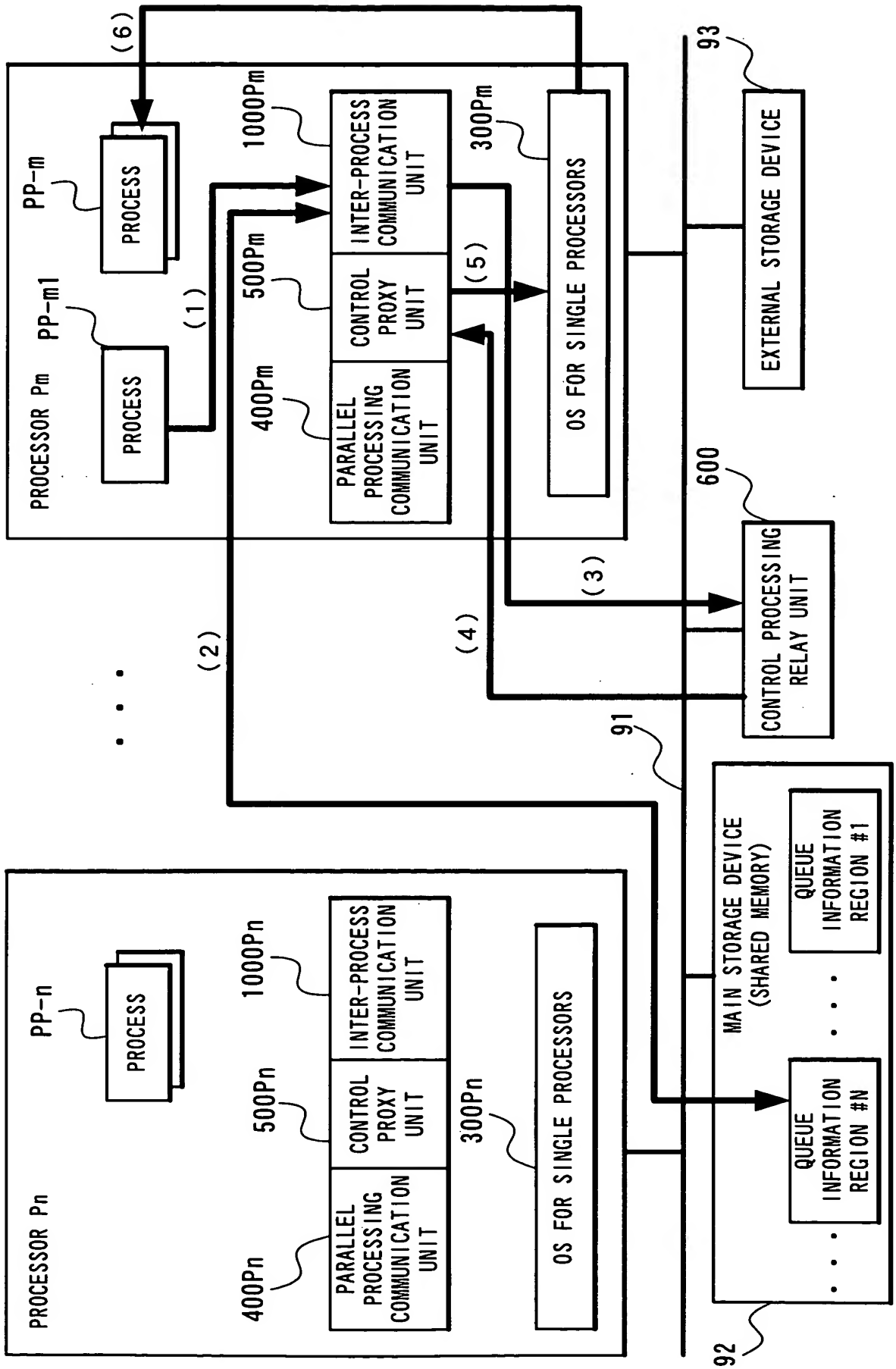


FIG. 26 (MESSAGE TRANSMISSION OPERATION BY MESSAGE QUEUE SYSTEM BETWEEN DIFFERENT PROCESSORS)

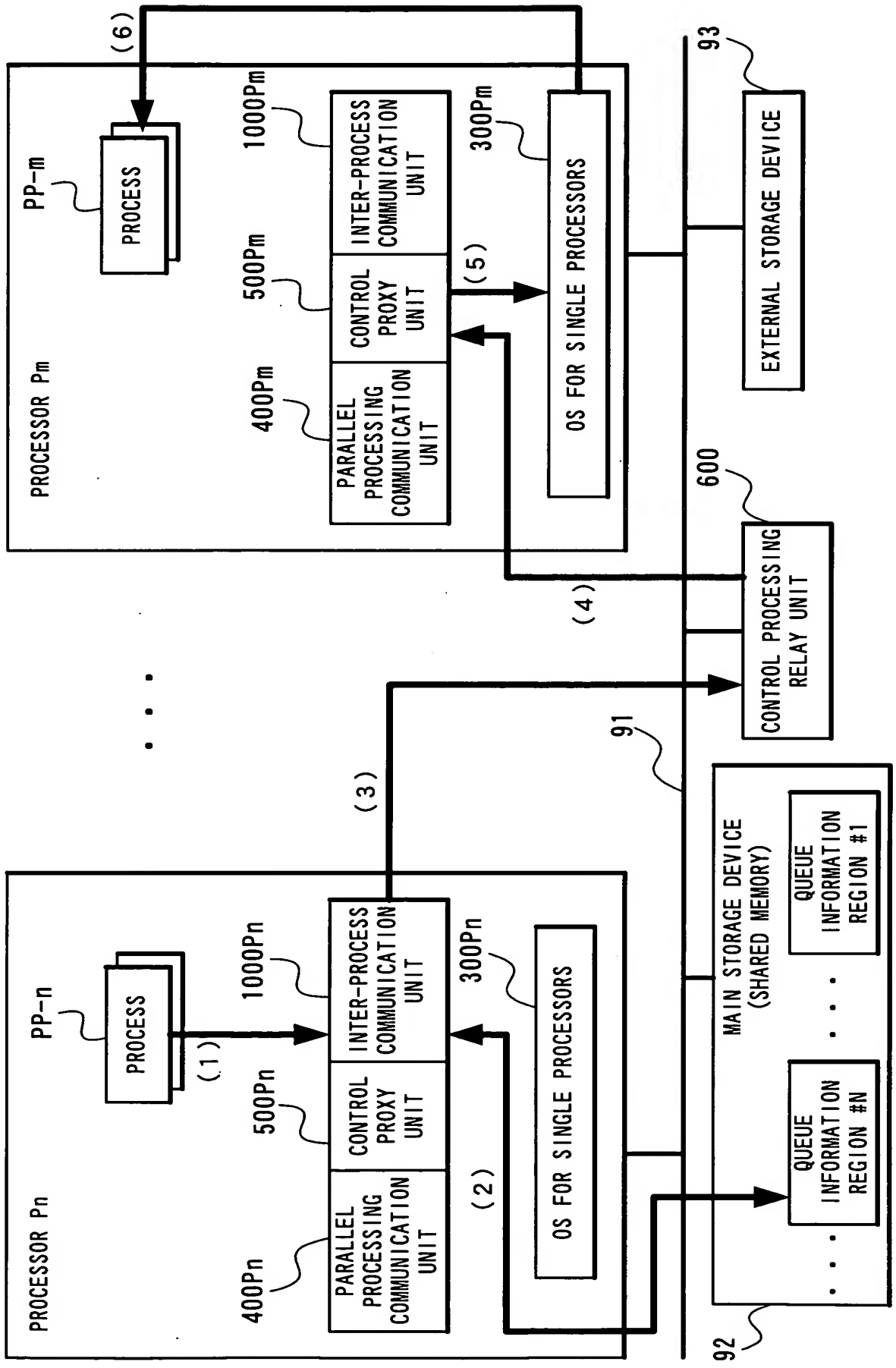


FIG.27

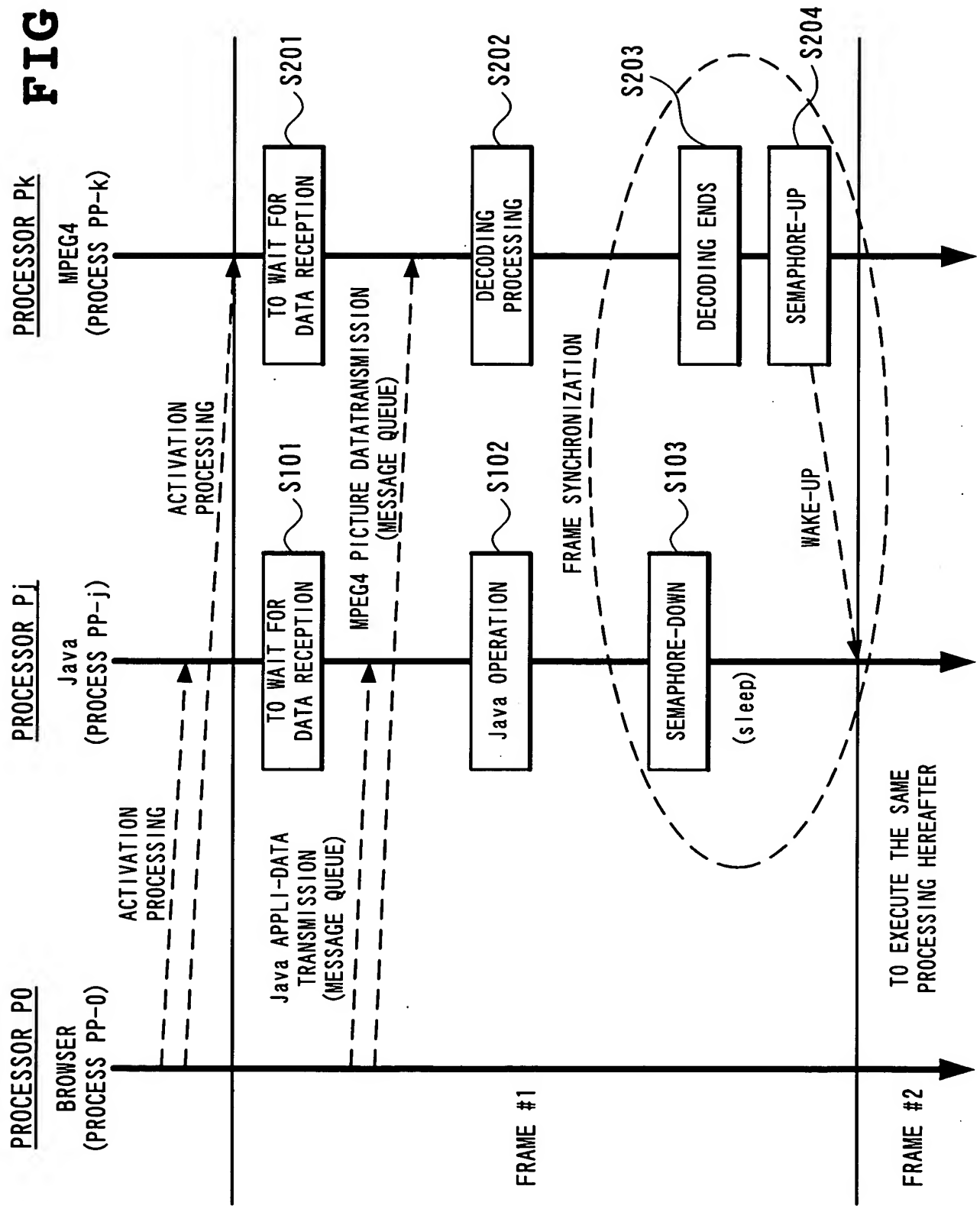

PROCESSOR Pk
MPEG4
(PROCESS PP-k)
PROCESSOR Pj
Java
(PROCESS PP-j)
PROCESSOR P0
BROWSER
(PROCESS PP-0)
ACTIVATION PROCESSING
ACTIVATION PROCESSING
Java APPLI-DATA TRANSMISSION (MESSAGE QUEUE)
TO WAIT FOR DATA RECEPTION
S101
MPEG4 PICTURE DATATRANSMISSION (MESSAGE QUEUE)
TO WAIT FOR DATA RECEPTION
S201
Java OPERATION
S102
DECODING PROCESSING
S202
FRAME SYNCHRONIZATION
SEMAPHORE-DOWN
S103
(sleep)
DECODING ENDS
S203
WAKE-UP
SEMAPHORE-UP
S204
TO EXECUTE THE SAME PROCESSING HEREAFTER
FRAME #1
FRAME #2

FIG.28

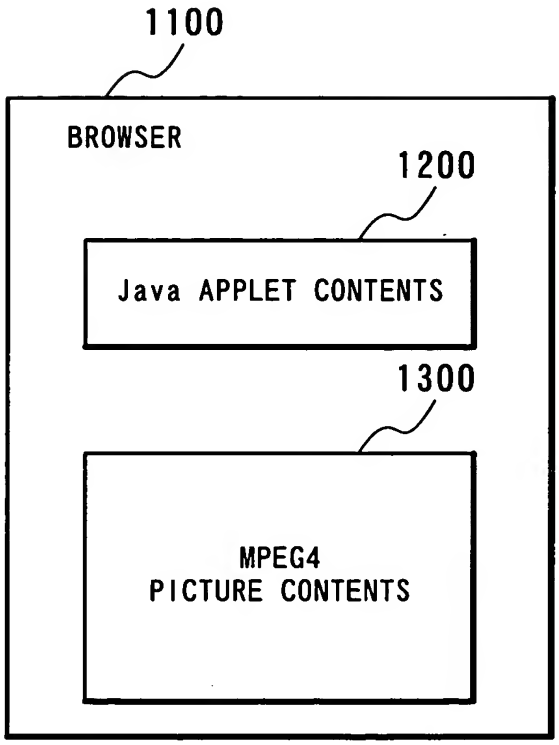
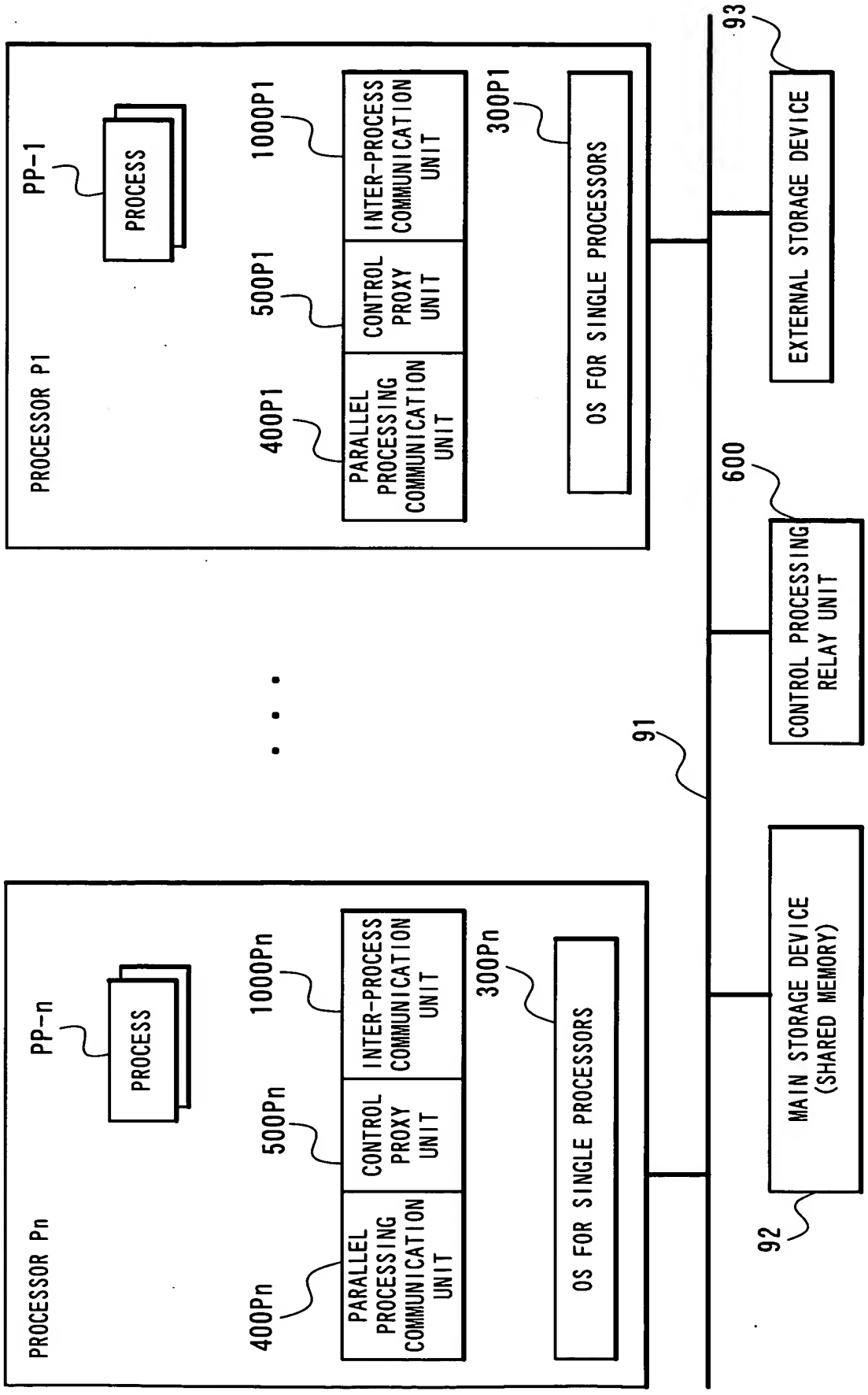

1100
BROWSER
1200
Java APPLET CONTENTS
1300
MPEG4
PICTURE CONTENTS

FIG.29


PROCESSOR P1
PP-1
PROCESS
400P1
PARALLEL PROCESSING COMMUNICATION UNIT
500P1
CONTROL PROXY UNIT
1000P1
INTER-PROCESS COMMUNICATION UNIT
300P1
OS FOR SINGLE PROCESSORS
PROCESSOR Pn
PP-n
PROCESS
400Pn
PARALLEL PROCESSING COMMUNICATION UNIT
500Pn
CONTROL PROXY UNIT
1000Pn
INTER-PROCESS COMMUNICATION UNIT
300Pn
OS FOR SINGLE PROCESSORS
91
92
MAIN STORAGE DEVICE (SHARED MEMORY)
600
CONTROL PROCESSING RELAY UNIT
93
EXTERNAL STORAGE DEVICE